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R. W. Baily

THE

ART of SHADOWS:

OR,

Universal Dialling;

WITH

TABLES exactly *Calculated* for the *Lat.* of 51 deg. 30 min. *viz.* London.

Teaching any Person, tho' of an ordinary *Capacity*, and unlearned in the MATHEMATICKS, to draw a true SUN-DIAL, upon any given PLAN, however *Situated*, in respect of *Declination* and *Reclination*.

AND

A TABLE shewing the Distance of each *Hour-line* from the *Meridian*, upon all *Horizontal-Dials*.

LIKEWISE

ARITHMETICAL, SPOT, CONCAVE, CONVEX, } { INSTRUMENTAL, REFLEX, CYLINDRICAL.

DIALLING.

WITH

The Manner of *Ornamenting* these several Sorts of *Dialling* with all Useful *Furniture*; and how to Cut the *five Regular Bodies*, and two others, one of Twelve *Rhombs*, and the other of Thirty.

The Third Edition, with Additions.

By JOHN GOOD, Teacher of Mathematicks.

LONDON:

Printed and Sold by THOMAS PAGE, and WILL. MOUNT, *on* Tower-hill, 1731.

D.

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TO THE

READER

HIS Treatise of Dialling *consisteth, a before, of* Geometrical *and* Instru mental Dialling: *And the Acceptanc it hath found among the Ingenious, hat Encouraged me to add a Third Par namely, an* Arithmetical *way by th Canons of Artificial Sines and Tangents: And ther are in it, as before, the Tables of Hour distances of al declining Dials, from one deg. of Declination to* 60 *deg which I have Calculated myself, and I think they ar very exactly done, so that you may depend upon them The Instruments by which Dialling may be performe are many, but amongst them all I think I have mad choice of the Best, namely, a Ruler, accomodated wit Scales and Lines necessary for that Purpose.*

The First *Scale, is a Scale of Hours, each Hour divided as the bigness of the Scale will permit, being proper for all Dials that have no Declination, as the Horizontal, the Direct* South *and* North, *whether Upright or Reclining, except the Stiles height be less than* 10 *deg. When that happens, there are other Scales for that Purpose; and this Scale hath the Letters (Hours) at the beginning.*

The Second *Scale, is a Scale of* 90 *deg. answerable to the Scale of Hours, and may be divided as the length of the Scale will* give leave: This Scale a *the first, will together* shew how many deg. and m *of the Equinoctial under,* &c.

The Third *Scale, is a Scale of Longitude, k*
by the Letters (Lat.) at the beginning.

The Fourth *and* Fifth *Scales, are two Scal*
Hours of a different length, either of them will
to make East West, *Equinoctial, and Equin*
declining Dials.

Both these Scales together, serve to draw all
Dials, whose Stile is but of small Elevation, an
Centre of the Dial is left out, aud are known b
Letters (G. Pol.) *and* (L. Pol.) *at the beginni*

It is proper to have two or three Lines of Chord
on your Ruler, of several Radu ses, and so have
compleat Ruler.

And therefore if any Person be delighted with
creation of this Nature, and hath not much Tin
spend, they are here fitted with an Instrument
will dispatch presently and perform it exactly; they
not to fear to lose themselves in a Wilderness of I
nor out run the limits of the Plane, by infinite E
sion, (two inconveniencies which the common w
Geometrical Dialling *is subject to,) they are*
acquitted of both, having nothing to do but to
the Dial *itself, contracted within the Limits o*
Plane. If any want Skill in the Mathematicl
them not deterr from this Subject, for there is litt
quired of them. If some think the Canon more e
so do I, but not so easy to be understood, nor so rea
use, nor so speedy in performance, nor truly so wel
ting the Capacities of all Persons. I shall say no
in Commendation of this Book, hoping it will spea
itself, I remain a Well wisher to the Mathemat

JOHN

To the AUTHOR, *on his Ingenious* BOOK, Intituled, *The* ART of SHADOWS: Or; UNIVERSAL DIALLING.

I.

DOes Time *(sub Deo) nolens volens* Rule
The Universe with uncontrolled Sway?
Do both Nature and Art, Wiseman and Fool,
His Law of Limit, all alike Obey?
Do all visible things on Time depend:
In Time Begin, Perfect, and make their End?

II.

Does every Orb of each denomination,
Whether the fixed Orbs or Wanderers,
Keep Time's unbroken Law of Limitation:
By *Minutes, Hours, Days, Weeks, Months, & Years*?
Does Time's Progress admit of no Cessation,
'Till Eternity stop his Numeration?

III.

Is Time that's past beyond retrivement lost,
Impossible to be restor'd again?
Does time that's present fly more swift than Post,
And ne'er one Moment, in one stay remain?
Can nothing stop Time's Feet, none hold his Wings,
Empires nor Emp'rors, Kingdoms nor their Kings?

IV.

Can neither Strength, Power, nor Policy?
Can neither Wisdom, Learning, Wit nor Art,
Riches, Grandeur, Honour, nor Majesty,
Stop Time's fleet Pace, or his Progress reverse?
Nor Favour, nor Interest, nor Bribery
Stay Time's swift Passage to Eternity?

Does Time more ſwift than *Thought* or *Fan*
Yet ſo, that he doth a fit Seaſon lend
To ev'ry Purpoſe underneath the Sun
For to Begin, Perfect, and make its En
Does Time rule all things, yet all things C
That will accept his Service, while they

VI.

If then, Time be the Beſt thing we Enjoy
Of all *Sub-lunar* Bleſſings we receive;
And greateſt Wiſdom be, Time well t'Im
Which being loſt, we never can retriev
Sure from theſe Premiſes, I may inferr,
To watch Time's Paſſage, ſhould be our *chi*

VII.

If ſo, then ſure ſure I may, (without denial
Affirm that the moſt Uſeful Art, which
The *Art* of *Shadows*, or a *True made Dial*,
From the Sun's bright Reflection, to eac
Doth ſhew us how, (by eaſy Definition)
This ſwift Accomptant, ſums up his Addi

VIII.

Then ſure above all, that e're writ the Ar
From Plainneſs, Fulneſs, Sho neſs, and Perfe
GOOD doth this Univerſal Good impart,
To all Capacities, by his Direction:
For both by Inſtruments, and Calculation,
GOOD above all, makes good his Applica

WM. BRITTAIN, *Phil*

Books *Printed and Sold by* Richard Mount *and* Thomas Page; *on* Tower-hill.

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Sir *Isaac Newton* and Mr. *Libnuire* relating to the fi
ventor of *Fluxions*.

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1. By a large and accurate Table of *Segments* of
cles, its Construction and various Uses of Solut
several difficult Problems, with Compendious Tabl
finding a true proportional Part, and their Use in
or any other Tables exemplify'd in making out L
thms or Natural Numbers from them to sixty Fi
there being a Table of them for all Primes to
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added, Twelve new Ones with various Methods of
ing them, and their exact Dimensions in Surdes or Sp
and in Numbers Illustrated with Variety of Copper-
by *Abraham Sharp*, Philomath.

A Necessary

INTRODUCTION;

Consisting of

PROBLEMS and DEFINITIONS

Geometrical and *Astronomical*:

FOR THE

More easy apprehending, and ready Performing of the several Matters and Things contain'd in the following TREATISE.

PROP. I. FIG. I.

Upon any Point (*as* O) *taken in the Right-Line* QR, *to erect a Perpendicular* OS.

1. OPEN your Compasses to any small Distance; and setting one Foot in the given Point O, with the other Foot makes Marks on both the sides of O, as at T and V.

2. Open the Compasses to any Distance, greater than the former, and setting one Foot in each the other describe the Arch bb: Also,

the ſame Diſtance, ſet one Foot in V, an
the other deſcribe the Arch *gg*, croſſing the
Arch *bb* in the Point S.

3. Draw the Line OS, and it will be *P*
cular to the given Line Q R.

PROB. II. FIG. II.

A Right-Line given, how to draw another Line, which ſhall be Parallel thereunto Diſtance required.

1. LET the Line given be AB, unto v
required to draw another Right-Li
which ſhall be Parallel to the former Lir
and at the Diſtance A C.

1. Open your Compaſſes to the Diſtan
then ſet one Foot in the Point A, with th
deſcribe the Arch C; Again, place one Fo
and with the other deſcribe the Arch D
draw the Line CD ſo that it may only tou
two Arches C and D, ſo ſhall the Line
drawn, be Parallel to A B, and at the D
required.

Aſtronomical Definitions.

THE Horizon is that part of the E
as a quick Eye can diſcern in a
Place; which divides the Heavens into tw
Parts. The middle Point of the Heavens
over our Heads, is called the Zenith;
under our Feet the Nadir.

2. The *Meridian* is a great Circle of the Heavens, passing through the Poles; the *Zenith* and *Nadir*, in which the Sun is at Noon, and at Twelve a Clock at Night.

3. The *Equinoctial* is a great Circle of the Heavens, dividing it into the Northern and Southern Hemispheres; and takes their Names from the two Poles, that being call'd the *Northern Hemisphere*, in which the *North-Pole* is seated; and that the *Southern* in which the *South-Pole* is seated. Unto this Circle when the Sun in his Annual Motion arriveth, (which is twice a Year) the Days and Nights are of an equal length through the whole World.

This Circle cutteth the *Axis* of the World at Right Angles, and is seated in the Heavens every ways 90 deg. distant from either of the *Poles*.

4. The two Topicks are *Smaller Circles* of the *Heavens*, described parallel to the *Equinoctial Circle*, and at 23 deg. 30 min. distance therefrom; that being the greatest *Declination* that the Sun hath from the *Equinoctial* towards either of the *Poles*. Of these Circles one is called the *Tropick of Cancer*, or Northern Tropick; the other the *Tropick of Capricon*, or Southern Tropick. These two Circles are the Bounds or Limits of the Sun's Course, for between them he always moveth, never going more Northward or Southward, (that is, declines not nearer to any of the Poles) than 23 deg. 30 min. Wherefore, when the Sun in his Annual Motion, shall arrive to the *Tropick of Cancer*, which is about the 10th or 11th of Jun[illegible] he maketh the longest Day; to all inhabit[illegible]

Northern Hemisphere. And when he arriveth to the *Tropick of Capricorn*, which is about the 11th of *December*, he maketh the shortest *Days* to those that inhabit the Northern, and the longest to those of the Southern Hemisphere.

How to find a True Meridian-line; *and the* Azimuth *of the* Sun.

IT is very necessary to have a true *Meridian-line*, which may be obtained many ways, but the best I know for Practice is this;

Get a plain thick Board of a Foot Square, or more, then in the middle, or as near as may be, fasten a strong Iron Pin, about three Inches long, and make it so fast, that it will not shake or yield in the least: It matters not whether it be exactly Perpendicular, or not.

Set this Board Horizontally, with Earth or Sand upon the Ground; about Nine a Clock see where the Head of this Iron-pin (which must be sharp at top) giveth its Shadow upon the Board, mark that Place: Then take a wooden Ruler, sharp also at the end, and lay it so, upon the sharp end of the Iron-Pin, that the sharp end of the Rular, may touch the Mark, then carrying it steady, describe a Circle.

Come again about Three a Clock in the Afternoon, and mark where the Shadow of the Top of the Iron-Pin is in that Circle again.

Draw a Line from those two Marks, which *will be East* and *West*, and the Perpendicular to *that Line will be* a true Meridian-Line.

But becauſe the Sun may be under a Cloud, when you come at three a Clock, you may make three or four more Circles, and uſe them as you uſed this.

When you have a true *Meridian-Line*, you will eaſily find the Sun's *Azimuth*, or Diſtance from the *South*; for hold but up a Plumb-line, and the Angle which the Shadow maketh with the *Meridian-Line* is the *Azimuth*; or you may lay the Edge of your *Quadrant* to the *Meridian-line*, and the Shadow of the Plumb-line paſſing through the Center, will give you the *Azimuth* in the Limb, and better than if you Calculated it by the Sun's *Altitude*.

How to make a Line of Chords to any Length or Radius.

FIrſt make a Right-line of any length as CBD, and upon the middle, by the firſt Problem, erect the Perpendicular A B.

Secondly, Open your Compaſſes to the Radius, or Length, that you would have your Line of Chords to be of, which ſuppoſe A B, and with that diſtance upon B, deſcribe the Semicircle C A D.

Thirdly, Your Compaſſes being open to the ſame diſtance you deſcrib'd the Semicircle, ſet one Foot in D, and make a mark in the Quadrant DA, as at R, then take with Compaſſes the diſtance on the Quadrant, from A to R, and ſet from R to S ſo the Quadrant will be divided into 30, 60, 9

deg. then divide D S, and S R, and R into three Parts, which will be 10, 2(50, 60, 70, 80 and 90.

Lastly, Set your Compasses in D, them to every one of the Nine Parts tha drant is divided into by 10, 20, *&c.* an the prick'd Line as you see in the Figu

Note: You may divide the Quadran you will, into 90 equal Parts, if your is large, and so transfer them from the to the Line C B D, as you did by e Degrees.

Prob. III. Fig. III.

The Latitude of the Place, the Declinat Sun, and the Altitude of the Sun be to find out the Azimuth, Geometrically.

	deg. m
The Latitude of the Place is	51 3
The Declinnation of the Sun is	20 9
The Altitude of the Sun is	18 2

I. Upon the Center Q. describe the S H Z O for half the Meridian, and upon the Perpendicular Q Z, for the Zenith

II. Set 51 deg. 30 min. of your Line o which is the Latitude of *London*, from and draw Æ Q from the Equinoctial.

III. Set 20 deg. 9 min. the Sun's De from Æ towards Z, to the Point D, (t *North)* and draw the Line D T parallel *so is DBT the Parallel* of the Sun's Decli

IV. Set 18 deg. 2 min. the Sun's Alti

from O to L, and from H to M, and draw the Line ML, for the *Parallel* of *Altitude*.

V. Take your Compasses, half the length of the *Parallel* of *Altitude* SL, or SM; and with that Distance upon Q, describe the innermost Semicircle ACG.

VI. From the Point B, which is where the *Parallel* of *Delination*, and the *Parallel* of *Altitude* do intersect, erect the *Perpendicular* BC, till it touch the innermost Semicircle.

VII. Lay a Ruler from Q to C, and it will cut the outermost Circle in E; so HE measured upon a Line of Chords be 80 deg. the Sun's *Azimuth* from the *North* part of the *Meridian*.

VIII. EZ shall be 10 deg. the *Azimuth* from the *East* or *West*.

IX. *Lastly*, EQ shall be 100 deg. the *Azimuth* from the *South* part of the *Meridian*.

Note; And whereas throughout this *Book* there is continual mention made of *Degrees* and *Minutes*; know, that a Degree is the 360th part of any Circle, each of which Degrees is supposed to be divided into 60 Parts called Minutes, so that 45 Min. is three quarters of a Degree, 30 Min. half a Degree, and 15 Min. one quarter of a Degree, &c.

A Table of the Sun's Declination.

Days.	January d.	January m.	Februa. d.	Februa. m	March d.	March m.	April d.	April m	May d.	May m.	June d.	June m.
1	21	44	13	46	3	24	8	36	18	5	23	12
2	21	33	13	26	3	0	8	58	18	20	23	16
3	21	23	13	5	2	37	9	20	18	35	23	19
4	21	13	12	45	2	13	9	42	18	50	23	22
5	21	2	12	25	1	49	10	3	19	4	23	25
6	20	50	12	3	1	25	10	24	19	18	23	27
7	20	38	11	43	1	1	10	45	19	31	23	29
8	20	26	11	21	0	38	11	0	19	44	23	30
9	20	13	11	0	0	14	11	27	19	57	23	31
10	20	0	10	38	0	10	11	47	20	10	23	32
11	19	46	10	16	0	33	12	7	20	22	23	31
12	19	32	9	54	0	57	12	28	20	34	23	31
13	19	18	9	32	1	21	12	48	20	45	23	30
14	19	3	9	10	1	44	13	7	20	56	23	29
15	18	48	8	48	2	8	13	27	21	7	23	28
16	18	32	8	25	2	31	13	46	21	17	23	26
17	18	17	8	3	2	54	14	5	21	27	23	23
18	18	2	7	40	3	18	14	24	21	37	23	20
19	17	45	7	17	3	41	14	42	21	46	23	17
20	17	28	6	54	4	5	15	1	21	55	23	14
21	17	11	6	31	4	28	15	19	22	4	23	10
22	16	54	6	8	4	51	15	37	22	12	23	6
23	16	36	5	45	5	14	15	54	22	20	23	1
24	16	18	5	21	5	37	16	12	22	27	22	55
25	16	0	4	58	6	0	16	29	22	34	22	50
26	15	42	4	34	6	22	16	46	22	41	22	44
27	15	23	4	11	6	45	17	2	22	47	22	37
28	15	4	3	47	7	7	17	18	22	53	22	31
29	14	45	3	39	7	30	17	34	22	59	22	23
30	14	26			7	52	17	50	23	3	22	16
31	14	6			8	14			23	8		

South. North.

A Table of the Sun's Declination.

Days	July d.	July m.	August d.	August m.	Septem. d.	Septem. m	October d.	October m.	Novem. d.	Novem. m	Decem. d.	Decem. m
1	22	8	15	12	4	24	7	15	17	40	23	9
2	22	0	14	55	4	2	7	38	17	56	23	13
3	21	51	14	36	3	38	8	0	18	12	23	17
4	21	42	14	17	3	15	8	22	18	28	23	20
5	21	32	13	58	2	52	8	45	18	43	23	23
6	21	22	13	39	2	29	9	7	18	58	23	26
7	21	12	13	20	2	5	9	29	19	13	23	28
8	21	2	13	1	1	42	9	51	19	27	23	30
9	20	51	12	41	1	19	10	13	19	41	23	31
10	20	40	12	21	0	55	10	33	19	55	23	31
11	20	28	12	1	0	32	10	56	20	8	23	31
12	20	16	11	41	0	8	11	18	20	21	23	31
13	20	4	11	21	0	16	11	39	20	34	23	29
14	19	51	11	0	0	39	12	0	20	46	23	27
15	19	38	10	39	1	3	12	21	20	58	23	25
16	19	25	10	18	1	26	12	41	21	9	23	22
17	19	12	9	57	1	50	13	2	21	20	23	19
18	18	58	9	36	2	13	13	22	21	31	23	16
19	18	43	9	15	2	37	13	42	21	41	23	12
20	18	23	8	53	3	0	14	2	21	50	23	7
21	18	14	8	31	3	25	14	21	22	0	23	2
22	17	59	8	9	3	47	14	41	22	9	23	0
23	17	44	7	47	4	10	15	0	22	15	22	57
24	17	28	7	25	4	33	15	19	22	17	22	51
25	17	12	7	3	4	57	15	37	22	33	22	44
26	16	56	6	41	5	20	15	55	22	40	22	27
27	16	39	6	18	5	46	16	1	22	46	22	30
28	16	22	5	56	6	6	16	3	22	52	22	22
29	16	6	5	33	6	29	16	49	22	58	22	15
30	15	48	5	10	6	52	17	6	23	2	22	5
31	15	30	4	47			17	28			22	56

North. | South.

The End of the Introduction.

How to find the Situation of any Plane, from the South *or* North, *towards either* East *or* West; *commonly called the Declination of a Plane.*

THE *Declination of a Plane*, is an Arch of the *Horizon* comprehended between the *Pole of the Plane*, and the *Meridian of the Place.* Or it is the distance of the *Plane itself*, from the prime *Verticle Circle*, or *Azimuth* of *East* and *West.*

To find out the *Declination of any Plane*, there are required two Observations to be made by the *Sun* at the same instant of time. The first of the *Sun's Horizontal distance from the Pole of the Plane*, and secondly, *of the Altitude of the Sun.*

First, To find the *Sun's Horizontal Distance from the Pole of the Plane.* Apply one edge of a Quadrant, to the *Horizontal-Line* of your Plane, so that the other may be Perpendicular to it, and the Limb of the Quadrant must be towards the *Sun*, and hold the whole *Quadrant Horizontal* as near as you can conjecture: Then holding up a Thread and Plummet, at full Liberty, so that the Shadow of the Thread, may pass both thro' the Center and Limb of the Quadrant, observe *then the Degrees* cut by the Shadow of the *Thread, and* number them from that side of the *Quadrant that standeth* square or Perpendicular

he Plane: For those Degrees are the *Horizontal Distance* required.

Secondly, This *Horizontal Distance* and the *Sun's Altitude* being observed at the same time (as near as may be) will help you to the *Planes Declination* in this manner.

When you make your Observation, of the *Sun's Horizontal Distance*, mark whether the Shadow of the Thread, fall between the *South*, and that side of the Quadrant which is Perpendicular to the Plane.

I. If the Shadow fall between them, the Azimuth and Distance added together, do make the *Declination of the Plane*, and in this Case the *Declination* is upon the *same Coast* whereon the *Sun's Azimuth* is.

II. If the Shadow fall not between them, subtract the lesser of them from the greater, and the remainder shall be the *Plane's Declination*; and if the *Azimuth* be the greater of the two, the Plane Declines to the same Coast whereon the Sun is, but if the *Distance* be the greater, then the Plane Declines to the contrary Coast.

And here Note, That the Declination thus found is always accounted from the *South*, and that all Declinations are counted from either *South* or *North*, towards either *East* or *West*; and must never exceed 90 Degrees.

I. If therefore the degrees of Declination do exceed 90, you must take the residue of that *Number* to 180, and that shall be the Plane *Declination* from the North.

II. If the Degrees of Declination exce
deg. then the excess above 180 deg. gi
Plane's Declination from the *North* towa
Coast, which is contrary to the Coast w
the Sun is.

But seeing the Declination is the Angl
tained between the Perpendicular from t
and the *Meridian*, it may be the best to wai
Weather, till you find the *Sun* in the *Me*
and then the Angle upon the Limb of th
drant, will itself be the Declination.

A

Description of DIALLI

DIALLING is an Art teaching
Measure the time of the Day, by th
of the *Sun*; and originally is a *Math*
Science, attained by the Philosophical t
plation of the motion of the *Sun*, the mo
the *Shadow*, the Constitution of the *Sph*
Situation of *Planes*, and the consideration
The motion of the *Sun* is regular, in
equal Space in equal Time; but the mo
the *Shadow* irregular in all parts of the Ea
less under the two Poles, and that more
according to the Constitution of the *Sph*
the Situation of the *Plane*.

And therefore by Art there is found out Rules to mark out the irregular Motion of the *Shadow* in all *Latitudes*, and on all *Planes*, to comply with the regular Motion of the Sun. And these Rules of adjusting the Motion of the *Shadow* to the motion of the *Sun*, may be called the Art of *Shadows*.

Of the several Sorts of Planes *upon which* DIALS *are usually made.*

Definitions.

A *Dial Plane* is that Flat whereon a Dial is intended to be made.

Of *Dial-Planes* some be *Direct*, others *Decliners*, and others *Oblique*.

Of *Direct Planes* there are five sorts.

1. The *Horizontal* whose Plane lies flat, and is parallel to the *Horizon*, beholding the *Zenith*.

2. The *South Erect*, whose Plane stands upright, and directly beholds the *South*.

3. The *North Erect*, whose Plane stands upright, and directly beholds the *North*.

4. The *East Erect*, whose Plane stands upright, and directly beholds the *East*.

5. The *West Erect*, whose Plane stands upright, and directly beholds the *West*.

Of *Decliners* there are infinite; and yet may be reduced into these two *Kinds*.

1. The *South Erect* Plane, declining more or less towards the *East* or *West*.

2.

2. The *North Erect* Plane, declining more or less towards the *East* or *West*.

Of *Oblique Planes* some are *Direct*, others *Declining*. Now an *Oblique* Plane is (as to explain it to a mean Capacity) a Plain, or Dial which falls or leaneth from you like the Roof of an House, and are of these Kinds:

1. The Direct *South*-Dial Reclining.
2. The Direct *North*-Dial Reclining.
3. The Direct *East* or *West* Reclining.
4. The *North* and *South* Declining Reclining Dials.

Note 1. That all Angles are usually measured by a Line of Chords, whose *Radius* or *Semidiameter* is equal to the Chord of 60 deg. and do contain 90 deg. which is a Quadrant; sometime by a Tangent-line.

2. If the Hours of a Dial be never so truly drawn, if the Stile be not well plac'd, it will not go exact; therefore observe these three Rules in setting your Stile.

1. That it has the same Center (if there be any) with the Substile and Hours.
2. Its due Angle.
3. That it stands perpendicular to the Substile.

THE
'rt of SHADOWS:
OR,
TABLES, &c.

CHAP. I. FIG. IV.

How to draw an Horizontal *Dial.*

RAW the Line AB, for 6 and 6 Morning and Evening.

2. Draw NS, perpendicular to AB; ; shall be the 12 a Clock Hour-line.

3. Let C, the Intersection of the foresaid Lines the Center of the Dial, then take in your mpasses 60 deg. of a Line of Chords, and with t Distance upon the Center C draw an obre Segment of a Circle, as A*m*B.

4. Turn to your Table of Horizontal Spaces, l see what Degrees and Minutes answer to 11 l 1 a Clock; you find they are 11 deg. 51 min. e therefore 11 deg. 51 min. out of your Line of ords, and set it from *m* to *bb*, on both sides 12 a Clock Line.

Likewise take 24 Deg. 20 Min. for 10 and 2 a ock, and set it from *m* to *bb*. Take 38 deg. *in. and set it* from *m* to *cc*; work after th *e manner* for the remaining Hours.

5. F

5. From the Center C, thro' each of these Points *a*, *b*, *c*, *d*, *e*, draw Lines, which shall be the Hours required. The intermedial Spaces, *viz.* Quarters, Half, and three Quarters of an Hour, are drawn after the same Method.

Lastly, The Stile of your Dial must always make an Angle equal to the *Latitude* of the Place. Take therefore 51 deg. 30 min. out of your Line of Chords and set it from *m* to *n*, thro' C and *n* draw the Line C*n*.

Note 1. That the Stile must stand at Right Angles with the *Plane* upon the 12 a Clock-Line.

2. That the 12 a Clock-Line must be set exactly *North* and *South*.

3. That the whole *Plane* must be laid parallel to the *Horizon*.

4. That the 2 Hours above the Line of 6, are drawn by extending the two opposite *Hour-lines* thro' the *Center*, as 4 in the Morning is drawn by extending 4 in the Afternoon, *&c.*

CHAP. II. FIG. V.

How to draw the Hour-lines *upon a* Direct South-Dial.

THERE is little Difference between describing a *South-Dial* and an *Horizontal-Dial*; only Observe,

1. *That the* Angle which every Hour-line *makes with the Meridian* must be taken from the *Table of South-Dial Spaces*, and prick'd down on th

he *Segment* of the Circle A, B, *m*, as before di-
ected in the *Horizontal Dial.*

2. That the Angle which the Stile makes with
he *Meridian* must be 38 deg. 30 min. always the
Complement of your *Latitude.*

Note; That the Stile must stand at Right An-
gles with the Plane.

2. That the Face of the Dial must look exactly
South, and be placed *perpendicular* to the *Horizon.*

CHAP. III. *Fig.* 6.

How to draw the Hour-lines *upon* a Direct North Dial.

A *Direct North Dial*, is the same with a *Direct South Dial*; for, if you take a *South-Dial* and turn it upside down, causing the Stile to point upwards, as the Stile of the *South* doth downwards, and leaving out the Hours near the *Meridian*, in these *Northern Latitudes*: as the Hours of 9, 10, 11, and 12 at Night, and 1, 2, and 3 in the Morning, all which time the Sun is under the *Horizon.* I say a *South-Dial* so inverted, and fixed against a direct *North Wall*, shall give the true Hour of the Day.

CHAP. IV. *Fig.* 7.

How to draw the Hour-lines *upon a* Direct, East *or* West Dial.

1. UPON the point C, if it be an East-Dial, or upon the point D, if a *West*, with 60 des of your line of Chords draw an obscure Segm

of a Circle EF; then take 38 deg. 30. min. the Complement of your *Latitude*, and set it from E to F, and draw C F thro' the *Plane*. Call this Line the *Equinoctial*.

2. Assume any two points in this *Equinoctial* at a convenient distance for the Hour-lines of 11 and 6; and thro' these points GH, draw *Perpendiculars* to the *Equinoctial*.

3. On G with 60 deg. of your Line of Chords, describe an obscure Arch of a Circle IK, and set thereon 14 deg. from I to K, and draw the Line GK, to cut the Hour-line of 6 in the Point L, so shall L H be the Height of the *perpendicular* Stile porportioned to this *Plane*.

4. Upon L with 60 deg. of Chords, describe an Arch of a Circle M, N: between the Hour-line 6 and G L. Divide the Arch MN, into five equal parts with 15 deg. of Chords. Then turn to your Table for *East* and *West Dials*, and see what number stands against each hour, (and the Intermediate Spaces, if you please to put them in) take the said numbers out of your Line of Chords; and put them upon the Arch MN, from M to N.

5. Lay a Rule from L to each of the Divisions ⊙⊙⊙, *&c*, and where the Rule intersects the Equinoctial-line, make marks ***, *&c*. Lines drawn thro' these points ***, *&c*. Parallel to the Hour-line of 6, shall be the true Hour-lines for an *East-Dial* from 6 to 11; but if you transfer the same distances on the Equinoctial before 6, as there is after 6, and thro' these distances *draw lines* parallel to 6; you have also the hours *before* 6, as 5, 4, *&c*.

Note; 1. That the Stile may be a plate of Br

or Iron of the same breadth as is the distance between 6 and 9 on the *Equinoctial*, and fixed upon the line of 6, perpendicular to the Plane.

2. That an *East* and *West Dial* is the same in all Respects, save that the hour-lines of 4, 5, 6, 7, 8, in the Morning in the *East Dial*, must be 8, 7, 6, 5, 4, in the Evening on the *West Dial*.

CHAP. V. *Fig.* 8.

How to draw the Hour-lines *upon* South *or* North Planes, *Declining either* East *or* West, 30 *degr.*

1. DRAW the Line NS for 12 a Clock Hour-line.

2. In this Line choose a Center as C, upon which with 60 degrees of Chords, describe an obscure Circle.

3. Turn to your Table of *Requisites*, and see what is the Substiles distance for 30 Degrees of *Declination*; 'Tis 21 deg. 40 min. take the said distance out of your Line of Chords, and set it from M to S: thro' C and S draw an obscure line for the Substile.

4. Now turn to your *Declination* in the Tables of *Hour distances* for the Substile, and see what numbers stands against each Hour (and $\frac{1}{4}$ part if you would insert them in your Dial) transfer these numbers by help of your Line of Chords into the Circle from S, towards AB; and thro' the Points draw Lines from C, the Center of your Dial; these are the Hours required.

5. *And Lastly*, In your Table of Requisites, *under the Stiles height*, and opposite to 30 deg. *Declination*, you'll find 31 deg. 37 min.

this diſtance from S to T, then draw C T, an you have the height of the Stile or Gnomon.

Note 1. That the larger the Radius of you Line of Chords is, the better you may inſer the Hour-lines.

2. If the Declination be *Eaſt*, the Subſtile mu be placed on the left ſide of the *Meridian*: an thoſe hours that are next to the numbers in you Table muſt be uſed: But the contrary, if th Declination be *Weſt*.

3. If the Face of your Dial be towards th *North*, you muſt turn the Dial the Bottom up wards; and reckon the Hours the contrary way So a *South Eaſt Decliner* will be a *North Eaſt De cliner*, and a *South Weſt Decliner*, will be a *Nort Weſt Decliner* leaving out the Hour-lines, (whic will be needleſs) before Sun-ſetting, and afte Sun-riſing.

4. That the Stile muſt be fix'd upon the Sub ſtile, and ſtand at Right Angles with the *Plane*.

CHAP. VI. *Fig.* 9

How to draw the Hour-lines *upon an* Equinoctia Plane.

1. DRAW the Right Line AB, for the Hori zontal Line of the Plane, and croſs i about the middle thereof at Right Angles, wit a Line 12 Q 12, for the Meridian and Hour-lin *of* 12.

1. *Upon* the Line 12 Q 12, either above o *below* Q, *aſſume* any Point at S, and ſetting o *oot of your* Compaſſes therein, (it being oper

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Fig. 2.

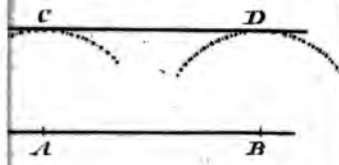


Fig. 4.

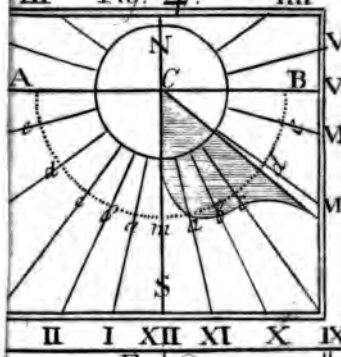
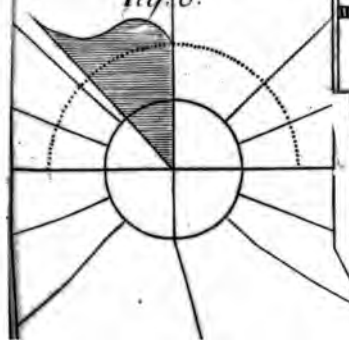


Fig. 6.



to the Radius of your Line of Chords) describe the Circle CDE, which divide into 12 equal parts, beginning at D.

3. Lay a Rule to S, and the several Points ⊙⊙⊙, *&c.* and it will cut the Line AB, in the Points ***, *&c.*

Lastly, Through these Points ***, *&c.* draw Right Lines all parallel to the Line 12 Q 12, and so your Dial is finished.

The Stile may be either a streight Pin, of the length of the Line QS, and set perpendicular to the Plane, upon the point Q; the shadow of the Top thereof only giving the Hour.

Or it may be a plate of Brass or Iron, of the breadth of the distance that is between the Hour-line of 12 and 3, or 12 and 9. And then will the shadow of the upper edge thereof give the true Hour of the Day.

CHAP. VII. *Fig.* 10.

How to draw the Hour-lines *upon a* Direct Polar Plane.

1. DEscribe the Circle ABDE, with 60 deg. of your Line of Chords.

2. Draw the Diameters AC and AD at Right Angles, in the Center O. AC shall be the hour of 12, and BD the hour of 6.

3. Turn to your Table of *Polar Dial*, and see what numbers answer to every hour, take the said Numbers from your Line of Chords, and *prick them down* in the Circle ABCD, on bo *sides the 12* a Clock-line: Draw lines from th *ints thro'* the Center O, and your work is

Note 1. That this *Plane*, by reason of its *North Reclination*, is in Summer, capable of receiving all the Hours from Sun-rising to Sun-setting, and therefore the Hour-lines of 4 and 5 in the Morning, and of 7 and 8 at Night, must be drawn through the Center, as you did in the *Horizontal Dial.*

2. That the Hour-line of 12 must stand exactly *North* and *South.*

3. That the Plane must be elevated the same number of Degrees towards the *South*, as the *Equator* is in your *Latitude.*

4. The Stile must be a streight Pin or Wire, (set perpendicular to the Plane, from the Center O) of any length.

5. The *South inclining Plane* opposite to this, is directly the same, only the Forenoon hours in this most be the Afternoon in that, and the hours of 4 and 5 in the Morning, and of 7 and 8 in the Evening, must be omitted.

CHAP. VIII. *Fig.* 11.

How to draw the Hour-lines *upon* Far-Declining Dials.

BEcause the Tables extend no farther than 60 deg. of Declination, (and if they had been Calculated to 90 deg. they would have been of little use, because the Stile's height being so small, the Hour lines would have been of no Competent Distance) and because many times there may be Occasion to make a Dial for a greater Declination, I will shew a Geometrical way to dra

draw such, by the help of a Line of Chords only.

Let the Declination given be 80 deg. Eastwards.

1. Draw a Line BC, perpendicular to the *Horizon* of the *Plane*.

2. Upon C, with a Chord of 60 deg. describe the Arch QS, then out of the Table of *Requisites* take the Substile's distance, and set it from Q to N; take also the Srile's height, and set it from N to *b*.

3. Draw CD for the Substile, and CE for the Stile: Then at any convenient distance draw KL parallel to CE the Stile. Also assume any two points in the Substile, and thro' them draw the Perpendiculars FG, and HI.

4. Take the nearest distance from T to KL, and from V to KL, and set it from T to R, and from V to D.

5. Upon D and R, with 60 deg. of Chords, describe two Arches of a Circle, and set off the Inclination of the *Meridian* from T to P, and from V to O. With 15 deg. of Chords divide the Segments into equal parts, beginning at O and P.

6. Lay a Rule on D, and on each division in the Arch V O, and mark the Intersection of the Rule with the Line FG. Then lay the Rule to R, and work after the same manner in other Arch, and HI.

7. Thro' the marks made in HI, and GF, draw the Hour-lines.

Note 1. When the *Plane* declines *Westward*, the perpendicular CB must be put on the Right-hand.

2. *That the* Inclination of the Meridian must *be set on the same side of the Substile with the Perpendicular.*

Thus have you finished your Dial, and in the making of this you have made a *South* declining *West* 80 deg. also; for if you turn the paper, and look through it, it will on the back-side be a *South* declining *West* 80 deg. only the Forenoon hours in this, must be Afternoon in that: Nay, of right you have made in this one Dial Four, *viz.* a *North*, declining either *East* or *West*, if you well observe what was said of the Dial declining 30deg.

CHAP. IX.

How to place an Upright Dial *truly.*

ALL *Upright Dials*, in what Latitude soever, have the *Meridian* perpendicular to the *Horizon*, Therefore set your Dial exact, hang a Line with a Plummet at the end thereof, upon a Nail fixt in the Line of 12 toward the top; then apply your Dial to the Place where it is to be fixt, so that the Line and Plummet may hang just down upon the Line of 12: The Dial thus fixt (if the Declination be truly taken, and the Dial made by the former directions) will at all times (if the *Sun*'s on it) give the true Hour of the Day.

Note. In every Dial truly placed, if you stand on the South-side of the Plane looking Northward, the Hours on your Left-hand of the *Meridian*, are the Morning-Hours, on your Right-hand are the Evening-Hours; but if you stand on the *North-side* of the Plane, your Face being Southward, *then the Forenoon*-Hours are on your Right-*hand, and the* Afternoon-hours on your Left-*hand; because* your Right-hand, in relation to *Plane, is where* your Left-hand was.

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5	18
8	39
9	38
10	47
11	56
33	04
34	12
35	19
36	25
37	31
38	36
39	41
40	46
41	49
42	52
43	5
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47	0
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he Three Requisites in Dialling, Calculated to every Degree of Declination, in the Latitude 51 deg. 30 min.

	Sub-stile's Distance Meridian.		Stile's height.		Inclination of Meridian.		Declination.	Sub-stile's Distance Meridian.		Stile's height.		Inclination of Meridian.	
	d.	m.	d.	m.	d.	m.		d.	m.	d.	m.	d.	m.
1	00	48	38	29	1	17	22	16	36	35	16	25	18
2	1	36	38	28	1	33	23	17	16	34	57	28	39
3	2	23	38	26	3	49	24	17	56	34	39	29	38
4	3	11	38	23	5	07	25	18	37	34	21	30	47
5	3	58	38	20	6	23	26	19	13	34	01	31	56
6	4	45	38	15	7	39	27	19	50	33	42	33	04
7	5	32	38	10	8	55	28	20	29	34	20	34	12
8	6	19	38	04	10	11	29	21	05	32	59	35	19
9	7	05	37	57	11	27	30	21	40	32	37	36	25
10	7	52	37	49	12	42	31	22	15	32	15	37	31
11	8	38	37	40	13	57	32	22	50	31	52	38	36
12	9	23	37	30	15	10	33	23	25	31	27	39	41
13	10	08	37	21	16	26	34	23	59	31	04	40	46
14	10	54	37	10	17	40	35	24	31	30	40	41	49
15	11	38	36	58	18	54	36	25	04	30	14	42	52
16	12	22	36	43	20	07	37	25	35	29	48	43	55
17	13	05	36	32	21	20	38	26	04	29	22	44	58
18	13	49	36	18	22	33	39	26	35	28	56	45	59
19	14	31	36	03	23	45	40	27	03	28	29	47	00
20	15	13	35	48	24	57	41	27	33	28	01	48	00
21	15	54	35	31	26	08	42	28	01	27	33	49	00

The Three Requisites in Dialling, Calcu-
ted to every Degree of Declination, in
Latitude 51 deg. 30 min.

Declination.	Sub-stile's Distance Meridian.		Stile's height.		Inclination of Meridian.		Declination.	Sub-stile's Distance Meridian.		Stile's height.		Inclination of Meridian.
	d.	m	d.	m.	d.	m.		d.	m	d.	m.	d.
43	28	29	27	05	50	00	67	36	13	14	05	71
44	28	55	26	36	50	59	68	36	25	13	29	72
45	29	21	26	07	51	57	69	35	36	12	53	73
46	29	46	25	37	52	55	70	36	46	12	18	74
47	30	11	25	07	53	55	71	36	55	11	41	74
48	30	35	24	38	54	50	72	37	06	11	06	75
49	30	38	24	06	55	46	73	37	15	10	29	76
50	31	21	23	35	56	42	74	37	24	09	53	77
51	31	45	23	04	57	38	75	37	32	09	16	78
52	32	05	32	32	58	33	76	37	40	08	40	78
53	32	26	22	00	59	28	77	37	47	08	03	79
54	32	46	21	28	60	23	78	37	57	07	27	80
55	33	06	20	55	61	17	79	37	59	06	49	81
56	33	24	20	22	62	10	80	38	04	06	12	82
57	33	42	19	49	63	04	81	38	09	05	35	82
58	34	00	19	16	63	57	82	38	14	04	58	83
59	34	15	18	42	64	49	83	38	17	04	20	84
60	34	33	18	06	65	41	84	38	21	03	44	85
61	34	47	17	34	66	33	85	38	23	03	06	86
62	35	05	17	00	67	24	86	38	26	02	28	86
63	35	18	16	25	68	16	87	38	28	01	52	87
64	35	34	15	50	69	07	88	38	29	01	15	88
65	35	43	15	15	69	57	89	38	29	00	37	89
66	36	00	14	40	70	47	90	38	30	00	00	90

A Table of Horizontal Spaces, shewing the *Distance* of each HOUR-LINE from the MERIDIAN upon DIRECT NORTH or SOUTH Planes, whether *Erect*, *Reclining* or *Inclining*: Calculated to every Degree of LATITUDE.

An Horizontal Dial, Latitude.	xi.	i.	x.	ii.	tx.	iii.	viii.	iv.	vii.	v.	vi.		*A Direct South Dial, Latitude.*
	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.	
0	0	0	0	0	0	0	0	0	0	0	0	00	90
1	0	16	0	34	1	0	1	44	3	44	90	00	89
2	0	32	1	9	2	0	3	27	7	25	90	00	88
3	0	48	1	44	3	0	5	11	11	3	90	00	87
4	1	5	2	19	4	0	6	54	14	36	90	00	86
5	1	20	2	52	4	58	8	35	18	1	90	00	85
6	1	36	3	27	5	58	10	16	21	19	90	00	84
7	1	52	4	3	6	57	11	55	24	27	90	00	83
8	2	8	4	37	7	55	13	33	27	23	90	00	82
9	2	23	5	9	8	54	15	10	30	17	90	00	81
10	2	40	5	43	9	51	16	44	32	57	90	00	80
11	2	55	6	17	10	48	18	17	35	27	90	00	79
12	3	11	6	51	11	45	19	48	37	49	90	00	78
13	3	27	7	24	12	41	21	17	40	1	90	00	77
14	3	43	7	57	13	36	22	44	42	4	90	00	76
15	3	58	8	30	14	31	24	9	44	0	90	00	75
16	4	13	9	2	15	25	25	31	45	49	90	00	74
17	4	29	9	35	16	26	26	52	47	26	90	00	73
18	4	44	10	8	17	10	28	9	49	4	90	00	72
19	4	59	10	39	18	2	29	25	50	33	90	00	71
20	5	14	11	10	18	53	30	39	51	55	90	00	70
21	5	29	11	41	19	44	31	50	53	9	90	00	69
22	5	44	12	13	20	32	32	58	54	21	90	00	68
23	5	59	12	43	21	20	34	5	55	30	90	00	67
24	6	13	13	13	22	8	35	10	56	37	90	00	66
25	6	28	13	43	22	55	36	12	57	34	90	00	65
26	6	42	14	12	23	40	37	13	58	34	90	00	64

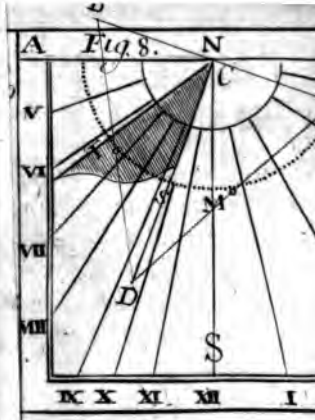
Fig. 8.
A
N
C
V
VI
VII
VIII
M
D
S
IX X XI XII I

Fig. 10
A
8
7
6
D
5
4
3
2
1
12
11
10
C

Fig. 12
The Frame.
The bottom Peic

Three Requisites in Dialling, Calculad to every Degree of Declination, in e Latitude 51 deg. 30 min.

ub-ile's Di-ance Meri-ian.		Stile's height.		Incli-nation of Me-ridian.		Declination.	Sub-stile's Di-stance Meri-dian.		Stile's height.		Incli-nation of Me-ridian.	
	m.	d.	m.	d.	m.		d.	m.	d.	m.	d.	m.
1	48	38	29	1	17	22	16	36	35	16	25	18
2	36	38	28	1	33	23	17	16	34	57	28	39
3	23	38	26	3	49	24	17	56	34	39	29	38
4	11	38	23	5	07	25	18	37	34	21	30	47
5	58	38	20	6	23	26	19	13	34	01	31	56
6	45	38	15	7	39	27	19	50	33	42	33	04
7	32	38	10	8	55	28	20	29	34	20	34	12
8	19	38	04	10	11	29	21	05	32	59	35	19
9	05	37	57	11	27	30	21	40	32	37	36	25
10	52	37	49	12	42	31	22	15	32	15	37	31
11	38	37	40	13	57	32	22	50	31	52	38	36
12	23	37	30	15	10	33	23	25	31	27	39	41
13	08	37	21	16	26	34	23	59	31	04	40	46
14	54	37	10	17	40	35	24	31	30	40	41	49
15	38	36	58	18	54	36	25	04	30	14	42	52
16	22	36	43	20	07	37	25	35	29	48	43	55
17	05	36	32	21	20	38	26	04	29	22	44	58
18	49	36	18	22	33	39	26	35	28	56	45	59
19	31	36	03	23	45	40	27	03	28	29	47	00
20	13	35	48	24	57	41	27	33	28	01	48	00
21	54	35	31	26	08	42	28	01	27	33	49	00

The Three Requisites in Dialling, Calcul
ted to every Degree of Declination, in t
Latitude 51 deg. 30 min.

Declination.	Sub-stile's Distance Meridian.		Stile's height.		Inclination of Meridian.		Declination.	Sub-stile's Distance Meridian.		Stile's height.		Incl nati of M ridia
	d.	m	d.	m.	d.	m.		d.	m	d.	m.	d.
43	28	29	27	05	50	00	67	36	13	14	05	71
44	28	55	26	36	50	59	68	36	25	13	29	72
45	29	21	26	07	51	57	69	35	36	12	53	73
46	29	46	25	37	52	55	70	36	46	12	18	74
47	30	11	25	07	53	55	71	36	55	11	41	74
48	30	35	24	38	54	50	72	37	06	11	06	75
49	30	38	24	06	55	46	73	37	15	10	29	76
50	31	21	23	35	56	42	74	37	24	09	53	77
51	31	45	23	04	57	38	75	37	32	09	16	78
52	32	05	32	32	58	33	76	37	40	08	40	78
53	32	26	22	00	59	28	77	37	47	08	03	79
54	32	46	21	28	60	23	78	37	57	07	27	80
55	33	06	20	55	61	17	79	37	59	06	49	81
56	33	24	20	22	62	10	80	38	04	06	12	82
57	33	42	19	49	63	04	81	38	09	05	35	82
58	34	00	19	16	63	57	82	38	14	04	58	83
59	34	15	18	42	64	49	83	38	17	04	20	84
60	34	33	18	06	65	41	84	38	21	03	44	85
61	34	47	17	34	66	33	85	38	23	03	06	86
62	35	05	17	00	67	24	86	38	26	02	28	86
63	35	18	16	25	68	16	87	38	28	01	52	87
64	35	34	15	50	69	07	88	38	29	01	15	88
65	35	43	15	15	69	57	89	38	29	00	37	89
66	36	00	14	40	70	47	90	38	30	00	00	90

A *Table* of Horizontal Spaces, shewing the *Distance* of each HOUR-LINE from the MERIDIAN upon DIRECT NORTH or SOUTH Planes, whether *Erect*, *Reclining* or *Inclining*: Calculated to every Degree of LATITUDE.

An Horizontal Dial, Latitude.	xi. d.	i. m.	x. d.	ii. m.	ix. d.	iii. m.	viii. d.	iv. m.	vii. d.	v. m.	vi. d.	m.	*A Direct South Dial, Latitude.*
0	0	0	0	0	0	0	0	0	0	0	0	00	90
1	0	16	0	34	1	0	1	44	3	44	90	00	89
2	0	32	1	9	2	0	3	27	7	25	90	00	88
3	0	48	1	44	3	0	5	11	11	3	90	00	87
4	1	5	2	19	4	0	6	54	14	36	90	00	86
5	1	20	2	52	4	58	8	35	18	1	90	00	85
6	1	36	3	27	5	58	10	16	21	19	90	00	84
7	1	52	4	3	6	57	11	55	24	27	90	00	83
8	2	8	4	37	7	55	13	33	27	23	90	00	82
9	2	23	5	9	8	54	15	10	30	17	90	00	81
10	2	40	5	43	9	51	16	44	32	57	90	00	80
11	2	55	6	17	10	48	18	17	35	27	90	00	79
12	3	11	6	51	11	45	19	48	37	49	90	00	78
13	3	27	7	24	12	41	21	17	40	1	90	00	77
14	3	43	7	57	13	36	22	44	42	4	90	00	76
15	3	58	8	30	14	31	24	9	44	0	90	00	75
16	4	13	9	2	15	25	25	31	45	49	90	00	74
17	4	29	9	35	16	26	26	52	47	26	90	00	73
18	4	44	10	8	17	10	28	9	49	4	90	00	72
19	4	59	10	39	18	2	29	25	50	33	90	00	71
20	5	14	11	10	18	53	30	39	51	55	90	00	70
21	5	29	11	41	19	44	31	50	53	9	90	00	69
22	5	44	12	13	20	32	32	58	54	21	90	00	68
23	5	59	12	43	21	20	34	5	55	30	90	00	67
24	6	13	13	13	22	8	35	10	56	37	90	00	66
25	6	28	13	43	22	55	36	12	57	34	90	00	65
26	6	42	14	12	23	40	37	13	58	34	90	00	64

A TABLE of *Horizontal Spaces*, &c.

An Horizontal Dial, Latitude.	xi. i. d.	m.	x. ii. d.	m.	ix. iii. d.	m.	viii. iv d.	m.	vii. v. d.	m.	vi. d.	m.	A Direct South Dial, Latitude.
27	6	56	14	41	24	25	38	11	59	27	90	00	63
28	7	10	15	10	25	9	39	7	60	17	90	00	62
29	7	24	15	40	25	53	40	2	61	4	90	00	61
30	7	58	16	6	26	33	40	54	61	49	90	00	60
31	7	50	16	34	27	15	41	44	62	30	90	00	59
32	8	5	17	1	27	55	42	30	63	11	90	00	58
33	8	19	17	27	28	34	43	20	63	49	90	00	57
34	8	31	17	54	29	13	44	5	64	24	90	00	56
35	8	44	18	20	29	50	44	49	64	58	90	00	55
36	8	57	18	45	30	27	43	31	65	30	90	00	54
37	9	10	19	9	31	2	46	12	66	10	90	00	53
38	9	22	19	34	31	37	46	50	66	29	90	00	52
39	9	34	19	58	32	11	47	28	66	56	90	00	51
40	9	45	10	21	32	44	48	7	67	21	90	00	50
41	9	57	20	44	33	16	48	39	67	47	90	00	49
42	10	10	21	7	33	46	49	12	68	11	90	00	48
43	10	22	21	29	34	18	49	44	68	33	90	00	47
44	10	32	21	51	34	47	50	10	68	54	90	00	46
45	10	43	22	12	35	17	50	46	69	15	90	00	45
46	10	54	22	23	35	44	51	15	69	35	90	00	44
47	11	05	22	53	36	11	51	42	69	53	90	00	43
48	11	17	23	13	36	37	52	9	70	11	90	00	42
49	11	25	23	33	37	3	52	35	70	28	90	00	41
50	11	35	23	52	37	28	53	00	70	43	90	00	40
51	11	45	24	5	37	52	53	24	70	59	90	00	39
52	11	55	24	27	38	15	53	46	71	13	90	00	38
53	12	5	24	43	38	37	54	18	71	28	90	00	37
54	12	13	25	2	38	58	54	29	71	41	90	00	36
55	12	22	25	18	39	19	54	49	71	54	90	00	35
56	12	32	25	34	39	40	55	9	72	5	90	00	34
57	12	4	25	50	39	59	55	28	72	17	90	00	33
58	12	48	26	5	40	81	55	45	72	28	90	00	32

A TABLE of *Horizontal Spaces*, &c.

An Horizontal Dial, Latitude.	xi. i.		x. ii		ix. iii.		viii. iv		vii. v.		vi.		A Direct South Dial, Latitude.
	d.	m.	d.	m	d.	m.	d.	m.	d.	m.	d.	m.	
59	12	46	26	20	40	36	56	3	72	38	90	00	31
60	13	4	26	34	40	54	56	19	72	48	30	00	30
61	13	11	26	47	41	10	56	34	72	58	90	00	29
62	13	19	27	1	41	21	56	49	73	7	90	00	28
63	13	26	27	13	41	42	57	3	73	15	90	00	27
64	13	32	27	25	41	57	57	17	73	24	90	00	26
65	13	39	27	37	42	15	57	30	73	32	90	00	25
66	13	46	27	49	42	25	57	43	73	39	90	00	24
67	13	51	27	59	42	38	57	54	73	46	90	00	23
68	13	57	28	9	42	50	58	5	73	53	90	00	22
69	14	3	28	19	43	2	58	16	73	59	90	00	21
70	14	8	28	29	33	13	58	26	74	05	90	00	20
71	14	13	28	27	43	18	58	35	74	11	90	00	19
72	14	18	28	46	43	24	58	44	74	16	90	00	18
73	14	22	28	54	43	36	58	52	74	20	90	00	17
74	14	27	29	2	43	52	59	00	74	25	90	00	16
75	14	30	29	7	44	00	59	7	74	30	90	00	15
76	14	33	29	15	44	8	59	15	74	34	90	00	14
77	14	37	29	21	44	14	59	22	74	37	90	00	13
78	14	41	29	27	44	22	59	27	74	41	90	00	12
79	14	44	29	32	44	28	59	32	74	44	90	00	11
80	14	47	29	37	44	34	59	37	74	47	90	00	10
81	14	49	29	41	44	37	59	40	74	49	90	00	9
82	14	51	29	45	44	40	59	44	74	51	50	00	8
83	14	53	29	49	44	44	59	47	73	53	90	00	7
84	14	55	29	52	44	48	59	51	74	55	90	00	6
85	14	56	29	54	44	53	59	54	74	57	90	00	5
86	14	57	29	55	44	55	59	55	74	58	90	00	4
87	14	58	29	56	44	56	59	56	74	58	90	00	3
88	14	59	29	57	44	57	59	58	74	59	90	00	2
89	14	59	29	58	44	58	59	59	74	59	90	00	1
90	15	00	30	00	45	00	60	00	75	00	90	00	

A Table of *Horizontal Spaces*; Exactly Calculated for the *Latitude* of *LONDON*: Shewing what Angle, every Five Minutes makes with the *Meridian*, upon an *Horizontal-Dial*.

Hours.		d.	m.	*Hours.*		d.	m.	*Hours.*		d.	m.
xii.		00	00	ii.	x.	24	20	iv.	viii.	53	36
5	55	00	59	5	55	25	25	5	55	54	59
10	50	1	58	10	50	26	30	10	50	56	23
15	45	2	57	15	45	27	37	15	45	57	48
20	40	3	55	20	40	28	44	20	40	59	14
25	35	4	54	25	35	29	51	25	35	60	40
30	30	5	53	30	30	30	59	30	30	62	10
35	25	6	53	35	25	32	00	35	25	63	35
40	20	7	52	40	20	33	18	40	20	65	4
45	15	8	51	45	15	34	29	45	15	66	34
50	10	9	51	50	10	35	40	50	10	68	4
55	5	10	51	55	5	36	51	55	5	69	35
i.	xi.	11	51	iii.	ix.	38	4	v.	vii.	71	6
5	55	12	51	5	55	39	17	5	55	72	39
10	50	13	52	10	50	40	31	10	50	74	12
15	45	14	53	15	45	41	45	15	45	75	45
20	40	15	54	20	40	43	1	20	40	77	20
25	35	16	56	25	35	44	18	25	35	78	35
30	30	17	58	30	30	45	35	30	30	80	27
35	25	19	00	35	25	46	55	35	25	82	2
40	20	20	04	40	20	48	12	40	20	83	36
45	15	21	07	45	15	49	31	45	15	85	13
50	10	23	11	50	10	50	52	50	10	86	49
55	0	23	12	55	5	52	13	55	5	88	24
								vi.	vi.	90	00

Table shewing what Angle every Hour Quarters, Halfs, and Three Quarters of an Hour, makes in a Direct South-Dial.

Hours.	d.	m.
ii.	00	00
3	2	21
2	4	41
1	7	4
xi.	9	28
3	11	57
2	14	28
1	17	4
x.	19	46
3	22	35
2	25	32
1	28	38
ix.	31	54
3	35	22
2	39	3
1	42	58
viii.	47	9
3	51	37
2	56	21
1	61	24
vii.	66	43
3	72	17
2	78	3
1	83	59
	90	

A Table for East and West-Dials

Hours.		d.	m.
vi.		00	00
1	3	3	45
2	1	7	30
3	1	11	15
viii.	v.	51	00
1	3	18	45
2	2	22	30
3	1	26	15
viii.	iv.	30	00
1	3	33	45
1	2	37	30
3	1	41	15
ix.	iii.	45	00
1	3	48	45
2	2	52	30
3	1	56	15
x.	ii.	60	00
1	3	63	45
2	2	67	30
3	1	72	15
xi.	i.	75	00

A Table shewing what Angle every Hour, Quarters, Halfs, and Three Quarters of an Hour makes in a Polar Dial.

Hours.		d.	m.
xii.		00	00
1	3	3	45
2	2	7	30
3	1	11	15
i.	xi.	15	00
1	3	18	45
2	2	22	30
3	1	26	15
ii.	x.	30	00
1	3	33	45
2	2	37	30
3	1	41	15
iii.	ix.	45	00
1	3	58	45
2	2	52	30
3	1	56	15
iv.	viii.	60	00
1	3	63	45
2	2	67	30
3	1	72	15
v.	vii.	75	00
1	3	78	45
2	2	82	30
3	1	86	15
	vi.	90	0

A TABLE of *Hour Distances*, and Parts of a *Hour* from the *Substile*, in *Declining Dials*, in th Latitude 51 deg. 30 min.

South Declining 1. 00.			*South Declining* 2 00.			*South Declining* 3. 00.		
Hours.	d.	m	*Hours.*	d.	m.	*Hours.*	d.	m
vi.	93	28	vi.	94	06	vi.	96	0
1 3	86	2	1 3	86	28	1 3	90	0
2 2	80	4	2 2	80	24	2 2	84	0
3 3	74	14	3 1	76	11	3 1	78	0
vii. v.	68	35	vii. v.	70	27	vii. v.	72	2
1 3	63	11	1 3	64	58	1 3	66	4
2 2	58	2	2 2	59	44	2 2	61	2
3 1	53	11	3 1	54	47	3 1	56	2
viii. iv.	48	38	viii. iv.	50	08	viii. iv.	52	1
1 3	44	22	1 3	45	46	1 3	47	1
2 2	39	41	2 2	41	40	2 2	43	0
3 1	36	47	3 1	37	50	3 1	39	0
ix. iii.	33	3	ix. iii.	34	13	ix. iii.	35	2
1 3	28	52	1 3	30	49	1 3	31	5
2 2	25	44	2 2	27	36	2 2	28	3
3 1	22	48	3 1	24	33	3 1	25	3
x. ii.	20	43	x. ii.	21	39	x ii.	22	3
1 3	17	59	1 3	18	42	1 3	19	4
2 2	15	20	2 2	16	13	2 2	17	0
3 1	12	47	3 1	13	38	3 1	14	3
xi. i.	10	18	xi. i.	10	38	xi. i.	11	0
1 3	7	52	1 3	08	42	1 3	09	3
2 2	5	29	2 2	06	18	2 2	07	0
3 1	3	9	3 1	03	55	3 1	04	4
xii.	0	48	xii.	01	36	xii.	02	
Sub-	stile		Sub-	stile		1 3	00	
1 3	1	52	1 3	00	55	Sub-	stile	
2 3	3	53	2 2	03	05	2 2	02	
3 1	6	14	3 1	05	26	3 1	04	

(1)			(2)				(3)			
xi.	08	38	i.	xi.	07	49	i.	xi.	07	00
3	11	04	1	3	10	15	1	3	09	25
2	13	30	2	2	12	43	2	2	11	52
1	16	10	3	1	15	16	3	1	14	24
x.	18	50	ii.	x.	17	45	ii.	x.	17	00
3	21	36	1	3	20	39	1	3	19	41
2	24	30	2	2	23	30	2	2	22	30
1	82	05	3	1	27	01	3	1	25	27
ix.	30	45	iii.	ix.	29	39	iii.	ix.	28	32
3	34	09	1	3	33	00	1	3	31	48
2	37	45	2	2	36	32	2	2	35	16
1	41	46	3	1	40	15	3	1	38	56
viii.	45	41	iv.	viii.	44	17	iv.	viii.	42	52
3	50	07	1	3	48	33	1	3	47	02
2	54	04	2	2	53	05	2	2	51	30
1	59	58	3	1	57	55	3	1	56	14
vii.	64	51	v.	vii.	63	03	v.	vii.	61	16
3	70	21	1	3	68	27	1	3	66	38
2	76	04	2	2	74	06	2	2	72	09
1	81	55	3	1	79	57	3	1	77	56
i.	86	56		vi.	85	54		vi.	83	53

th Declining. 04 00.			*South Declining.* 05 00.			*South Declining.* 06 00.		
urs.	*D.*	*M.*	*Hours.*	*D.*	*M.*	*Hours.*	*D.*	*M.*
i.	99	12	2	2	88	13	2	2	90	25
3	92	12	3	1	82	11	3	1	84	12
2	86	11	vii.	v.	76	17	vii.	v.	78	14
1	80	11	1	3	70	32	1	3	72	25
v.	74	19	2	2	65	01	2	2	66	49
3	68	40	3	1	59	47	3	1	61	28
2	63	15	viii.	iv.	54	49	viii.	iv.	56	25
1	58	06	1	3	50	10	1	3	51	39
iv.	53	14	2	2	45	44	2	2	47	10
1	48	40	3	1	41	40	3	1	42	49
2	44	24	ix.	iii.	37	50	ix.	iii.	39	03
1	40	23	1	3	34	13	1	3	35	02

(4)				(5)				(6)			
ix.	ii.	36	37	2	2	30	49	2	2	31	54
1	3	33	40	3	1	27	36	3	1	28	38
2	2	29	44	x.	ii.	24	33	x.	ii.	25	22
3	1	26	35	1	3	21	39	1	3	22	35
x.	ii.	22	35	2	2	18	53	2	2	19	47
1	3	20	45	3	1	16	13	3	1	17	05
2	2	18	00	xi.	i.	13	36	xi.	i.	14	30
3	1	15	21	1	3	11	09	1	3	11	58
xi.	i.	12	49	2	2	08	49	2	2	09	31
1	3	10	20	3	1	06	23	3	1	07	07
2	2	07	55		xii.	03	50		xii.	04	45
3	1	05	52	1	3	01	38	1	3	02	25
	xii.	03	11		Sub-		ſtile.	2	2	00	06
1	3	30	51	2	2	03	53		Sub-		ſtile.
	Sub-		ſtile.	3	1	03	01	3	1	02	14
2	2	01	29	i.	xi.	05	23	i.	xi.	04	34
3	1	03	49	1	3	07	45	1	3	06	56
i.	xi.	06	11	2	2	10	10	2	2	09	20
1	3	08	44	3	1	12	38	3	1	11	46
2	2	10	43	ii.	x.	15	10	ii.	x.	14	17
3	1	13	30	1	3	17	48	1	3	16	52
ii.	x.	16	04	2	2	20	32	2	2	19	34
1	3	18	44	3	1	23	22	3	1	22	22
2	2	20	45	iii.	ix.	26	21	iii.	ix.	25	17
3	1	23	36	1	3	29	30	1	3	28	22
iii.	ix.	27	26	2	2	32	49	2	2	31	37
1	3	30	38	3	1	36	20	3	1	35	04
2	2	34	01	iv.	viii.	39	05	iv.	viii.	38	52
3	1	37	37	1	3	44	51	1	3	42	39
iv.	viii.	41	26	2	2	48	21	2	2	46	49
1	3	45	31	3	1	52	54	3	1	51	16
2	2	48	42	v.	vii.	57	44	v.	vii.	56	01
3	1	53	16	1	3	62	52	1	3	61	03
v.	vii.	59	28	2	2	68	16	2	2	66	23
1	3	64	41	3	1	73	57	3	1	71	58
2	2	70	11		vi.	79	46		vi.	77	46
3	1	75	53	1	3	85	45	1	3	83	43
	vi.	81	48								

uth Declining. 09 00			South Declining. 08 00			South Declining. 09 00		
urs.	D.	M.	Hours.	D.	M.	Hours.	D.	M.
2	92	18	2	294	26	2	296	16
1	86	14	3	188	17	3	190	23
v.	80	13	vii	v82	13	vii	v84	15
3	74	21	1	377	52	1	378	14
2	68	38	2	270	32	2	272	23
1	63	12	3	164	58	3	166	45
iv	58	02	viii	iv59	32	viii	iv61	23
3	53	10	1	354	45	1	356	38
2	48	35	2	250	04	2	251	31
1	44	18	3	145	40	3	147	02
iii	39	17	ix	iii41	24	ix	iii42	50
3	36	30	1	338	44	1	338	52
2	32	59	2	234	07	2	235	14
1	29	39	3	130	43	3	131	46
ii	26	30	x	ii27	30	x	ii28	24
3	23	32	1	324	49	1	325	25
2	20	49	2	221	36	2	222	29
1	17	57	3	118	49	3	119	41
i	15	19	xi	i16	10	xi	i17	10
3	12	47	1	313	56	1	314	26
2	10	20	2	211	07	2	211	06
1	07	54	3	108	42	3	109	21
ii	05	32	xii	06	19	xii	07	05
3	02	42	1	203	59	1	204	48
2	00	53	2	201	40	2	202	26
ib-	stile.		Sub-	stile.		3 Sub-	100	07 stile.
1	01	29	3	100	59			
xi	03	36	1	xi02	59	1	xi02	11
3	06	06	1	205	19	1	304	30
2	08	30	2	207	40	2	206	51
1	10	55	3	110	04	3	109	13
x	13	24	ii	x14	33	ii	x13	40
3	15	28	1	315	03	1	315	09
2	18	36	2	217	40	2	216	44
1	21	22	3	120	22	3	119	24

(7)				(8)				(9)			
iii.	ix.	24	19	iii.	ix.	23	13	iii	ix	22	08
1	3	27	16	1	3	26	11	1	3	25	09
2	2	30	28	2	2	29	19	2	2	28	10
3	1	33	50	3	1	32	37	3	1	31	25
iv	viii	37	26	iv	viii	36	08	iv	viii	34	15
1	3	42	16	1	3	39	52	1	3	38	30
2	2	45	20	2	2	43	52	2	2	42	22
3	1	49	21	3	1	48	08	3	1	46	34
v	vii	54	20	v	vii	52	40	v	vii	51	04
1	3	59	16	1	3	57	31	1	3	56	49
2	2	64	30	2	2	62	39	2	2	60	50
3	1	70	02	3	1	68	05	3	1	66	10
	vi	75	45		vi	73	46		vi	71	46
1	3	40	81	1	3	79	38	1	3	77	36

South Declining. 10 00			South Declining. 11 00			South Declining. 21 00		
Hours.	D.	M	Hours.	D.	M	Hours.	D.	M.
3	1 92	22	3	1 94	25	3	1 96	35
vii	v 86	15	vii	v 88	17	vii	v 90	20
1	3 80	12	1	3 82	10	1	3 84	01
2	2 74	16	2	2 76	11	2	2 78	03
3	1 68	32	3	1 70	22	3	1 72	10
viii	iv 63	04	viii	iv 64	48	viii	iv 66	29
1	3 57	53	1	3 59	30	1	3 61	05
2	2 53	00	2	2 54	30	2	2 55	19
3	1 48	25	3	1 49	49	3	1 51	12
ix	iii 44	07	ix	iii 45	25	ix	iii 46	42
1	3 40	06	1	3 41	19	1	3 42	30
2	2 36	21	2	2 37	59	2	2 38	36
3	1 32	49	3	1 33	53	3	1 34	56
x	ii 29	28	x	ii 30	30	x	ii 31	28
1	3 26	22	1	3 27	38	1	3 28	14
2	2 23	24	2	2 24	18	2	2 25	11
3	1 20	34	3	1 21	25	3	1 22	06

(10)				(11)				(12)			
i	i	17	15	xi	i	18	40	xi	i	19	29
	3	15	14	1	3	16	03	1	3	16	08
	2	12	43	2	2	13	30	2	2	14	16
	1	10	16	3	1	11	03	3	1	11	47
	xii	07	52		xii	08	38		xii	09	23
	3	05	31	1	3	06	17	1	3	07	00
	2	03	12	2	2	03	51	2	2	04	40
	1	00	54	3	1	01	39	3	1	02	23
Sub-		ftile.		Sub-		ftile.		i	xi	00	16
	xi	01	25	i	xi	00	38	Sub-		ftile.	
	3	03	43	1	3	02	57	1	3	02	11
	2	06	02	2	2	05	15	2	2	04	29
	1	08	24	3	1	07	35	3	1	06	48
	x	10	48	ii	x	09	59	ii	x	09	09
	3	13	13	1	3	12	42	1	3	11	34
	2	15	49	2	2	14	55	2	2	14	03
	1	18	27	3	1	17	30	3	1	16	36
i	ix	21	12	iii	ix	20	17	iii	ix	19	04
	3	24	03	1	3	23	01	1	3	22	09
	2	27	03	2	2	25	58	2	2	24	54
	1	30	14	3	1	29	05	3	1	27	57
	viii	33	36	iv	viii	32	23	iv	viii	31	11
	3	37	10	1	3	35	52	1	3	34	40
	2	41	00	2	2	39	36	2	2	38	15
	1	45	04	3	1	43	35	3	1	42	09
	vii	49	26	v	vii	47	51	v	vii	46	20
	3	54	04	1	3	52	37	1	3	50	49
	2	49	02	2	2	57	16	2	2	55	33
	1	64	17	3	1	62	16	3	1	60	37
	vi.	69	49		vi.	67	52		vi.	66	00
	3	75	36	1	3	73	35	1	3	71	39
	2	81	33	2	2	79	16	2	2	77	32

South Declining. 13 00.				South Declining. 14 00.				South Declining. 15 00			
Hours.		D.	M.	Hours.		D.	M.	Hours.		D.	M.
2	1	96	42	vii	v	94	25	vii	v	96	28
vii	v	90	43	1	3	88	13	1	3	91	16
1	2	86	11	2	1	82	01	8	2	84	02
2	2	80	04	3	1	75	58	3	1	77	54
3	1	74	03	viii	iv	70	06	viii	iv	71	56
viii	iv	68	08	1	3	64	29	1	3	66	12
1	3	62	48	2	2	59	10	2	3	60	46
2	2	57	35	3	1	54	09	3	1	55	38
3	1	52	42	ix	iii	49	27	ix	iii	50	50
ix	iii	48	04	1	3	45	02	1	3	46	21
1	3	43	48	2	2	40	58	2	2	42	09
2	2	39	48	3	1	37	08	3	1	38	14
3	1	36	02	x	ii	33	33	x	ii	34	35
x	ii	32	32	1	3	30	11	1	3	31	09
1	3	29	13	2	2	27	01	2	2	27	56
2	2	26	06	3	1	24	02	3	1	24	58
3	1	23	09	xi	i	21	11	xi	i	22	40
xi	i	20	21	1	3	18	51	1	3	19	15
1	3	17	38	2	2	15	21	2	2	16	37
2	2	13	04	3	1	13	20	3	1	14	16
3	1	12	27	xii		10	54	xii		11	38
xii		10	08	1	3	08	31	1	3	09	15
1	3	07	47	2	2	06	11	2	2	06	55
2	2	05	27	3	1	03	54	3	1	04	37
3	1	03	09	i	xi	01	36	i	xi	02	21
i	xi	00	53	Sub-		stile.		1	3	00	05
Sub-		stile.		1	3	00	39	Sub-		stile.	
1	3	01	24	2	2	02	55	2	2	02	10
2	2	03	41	3	1	05	12	3	1	04	26
3	1	06	00	ii	x	07	31	ii	x	06	43
ii	x	08	20	1	3	09	53	1	3	09	04
1	3	10	42	2	2	12	18	2	2	11	27
2	2	13	45	3	1	14	47	3	1	13	45
3	1	15	40	iii	ix	17	29	iii.	ix	16	25

(13)				(14)				(15			
iii	ix	18	16	1	3	19	18	1	3	19	02
1	3	21	00	2	2	22	01	2	2	21	47
2	2	23	50	3	1	24	56	3	1	24	36
3	1	26	49	iv.	viii.	28	50	iv.	viii.	27	41
iv	viii	30	00	1	3	32	06	1	3	30	53
1	3	33	20	2	2	35	35	2	2	34	18
2	2	36	54	3	1	39	19	3	1	37	56
3	1	40	48	v.	vii.	43	18	v.	vii.	41	41
v	vii	44	48	1	3	47	34	1	3	45	58
1	3	49	09	2	2	52	07	2	2	50	28
2	2	53	49	3	1	57	00	3	1	55	14
3	1	58	47	vi.		62	11	vi.		60	21
	vi	64	04	1	3	67	42	1	3	65	46
1	3	69	39	2	2	73	28	2	2	71	28
2	2	77	04	3	1	77	50	3	1	77	24

South Declining. 16 00.				South Declining. 17 00.				South Declining. 18 00.			
Hours.		D.	M.	Hours.		D.	M.	Hours.		D.	M.
vii.	v.	98	31	vii	v	100	33	vii	v	102	38
1	3	92	17	1	3	94	20	1	3	96	32
2	2	86	01	2	2	88	02	2	2	90	05
3	1	79	49	3	1	81	37	3	1	82	46
viii.	iv.	73	45	viii	iv	75	38	viii	iv	77	32
1	3	67	55	1	3	69	42	1	3	71	30
2	2	62	21	2	2	64	02	2	2	65	43
3	1	57	07	3	1	58	40	3	1	60	14
ix.	iii.	52	11	ix	iii	53	58	ix	iii	55	04
1	3	47	36	1	3	48	56	1	3	50	16
2	2	43	18	2	2	44	33	2	2	45	45
3	1	39	19	3	1	40	24	3	1	41	36
x.	ii.	35	35	x	ii	36	39	x	ii	37	42
1	3	22	05	1	3	32	29	1	3	34	04
2	2	28	29	2	2	29	45	2	2	30	44
3	1	25	43	3	1	26	37	3	1	27	29

(16)				(17)				(18)			
xi		i	22	48	xi		i	23	36	xi		i	24	28
1		3	20	01	1		3	20	50	1		3	21	38
2		2	17	22	2		2	17	45	2		2	18	54
3		1	14	49	3		1	15	35	3		1	16	18
	xii		12	22		xii		13	05		xii		13	49
1		3	09	57	1		3	10	41	1		3	11	24
2		2	07	37	2		2	08	21	2		2	09	02
3		1	05	14	3		1	06	05	3		1	06	44
i		xi	04	04	i		xi	02	37	i		xi	04	29
1		3	00	49	1		3	01	32	1		3	02	16
1	Sub-			ſtile.	1	Sub-			ſtile.	2		2	00	02
2		2	01	26	2		2	00	53		Sub-			ſtile.
3		1	03	40	3		1	02	56	3		1	02	12
ii		x	05	57	ii		x	05	11	ii		x	04	25
1		3	08	15	1		3	07	28	1		3	06	12
2		2	10	36	2		2	09	47	2		2	08	59
3		1	13	00	3		1	12	10	3		1	11	20
iii		ix	15	30	iii		ix	14	37	iii		ix	13	45
1		3	18	05	1		3	17	09	1		3	16	14
2		2	20	47	2		2	19	49	2		2	18	50
3		1	23	34	3		1	22	54	3		1	21	33
iv		viii	26	53	iv		viii	25	28	iv		viii	24	24
1		3	29	41	1		3	28	33	1		3	27	34
2		2	33	01	2		2	31	48	2		2	30	35
3		1	36	34	3		1	35	54	3		1	33	58
v		vii	40	22	v		vii	38	59	v		vii	37	36
1		3	44	26	1		3	42	58	1		3	41	29
2		2	48	48	2		2	47	53	2		2	45	40
3		1	53	30	3		1	51	49	3		1	50	01
	vi.		58	30		vi.		56	44		vi.		54	58
1		3	63	50	1		3	61	58	1		3	60	06
2		2	69	28	2		2	67	32	2		2	65	34
2		1	75	23	3		1	73	20	3		1	71	22

South Declining. 19 00			South Declining. 20 00			South Declining. 21 00		
Hours.	D.	M.	Hours.	D.	M.	Hours.	D.	M.
i 3	98	28	i 3	100	31	i 3	102	39
2 2	92	07	2 2	96	16	2 2	96	14
3 1	85	44	3 1	83	47	3 1	89	48
viii iv	79	28	viii iv	81	25	viii iv	83	22
i 3	73	19	i 3	75	11	i 3	77	02
2 2	67	26	2 2	69	10	2 2	70	55
3 1	61	50	3 1	63	27	3 1	65	04
ix iii	56	32	ix iii	57	21	ix iii	59	32
i 3	51	37	i 3	53	00	i 3	54	32
2 2	47	00	2 2	48	16	2 2	49	31
3 1	42	44	3 1	43	45	3 1	45	02
x ii	38	45	x ii	39	59	x ii	40	53
i 3	35	02	i 3	36	02	i 3	37	01
2 2	31	35	2 2	32	32	2 2	33	25
3 1	28	20	3 1	29	12	3 1	30	03
xi i	25	17	xi i	26	06	xi i	26	51
i 3	22	23	i 3	23	10	i 3	23	56
2 2	17	39	2 2	20	24	2 2	21	08
3 1	19	02	3 1	17	45	3 1	18	28
xii	14	31	xii	15	13	xii	15	54
i 3	12	00	i 3	12	47	i 3	13	26
2 2	09	44	2 2	13	25	2 2	11	04
3 1	07	26	3 1	08	07	3 1	08	23
i xi	05	11	i xi	05	52	i xi	06	32
i 3	02	59	i 3	03	37	i 3	04	18
2 2	00	44	2 2	01	26	2 2	02	27
Sub-	ſtile.		Sub-	ſtile.		Sub-	ſtile.	
3 1	01	28	3 1	00	46	3 1	00	04
ii x	03	41	ii x	02	58	ii x	02	14
i 3	05	56	i 3	05	10	i 3	04	27
2 2	08	12	2 2	07	25	2 2	06	40
3 1	10	31	3 1	09	43	3 1	08	55
iii ix	12	53	iii ix	12	03	iii ix	11	13
i 3	15	41	i 3	14	28	i 3	13	36

(19)			(20)			(21)		
2	2	17	54	2	2	16	58	2	2	16	05
3	1	20	34	3	1	19	35	3	1	18	37
iv	viii	23	20	vi	viii	22	19	iv	viii	21	18
1	3	26	41	1	3	25	11	1	3	24	07
2	2	29	24	2	2	28	14	2	2	27	05
3	1	32	41	3	1	31	28	3	1	30	15
v	vii	36	15	v	vii	24	56	v	vii	23	38
1	3	40	04	1	3	38	38	1	3	37	14
2	2	44	07	2	2	42	37	2	2	41	08
3	1	48	30	3	1	46	54	3	1	45	18
	vi	53	13		vi	51	30		vi	49	49
1	3	58	16	1	3	56	27	1	3	54	40
2	2	63	38	2	2	61	45	2	2	59	52
3	1	69	21	3	1	67	23	3	1	65	25
vii	v	75	21	vii	v	73	19	vii	v	71	17

South Declining. 22 00			South Declining. 23 20			South Declining. 24 00		
Hours.	D.	M.	Hours.	D.	M.	Hours.	D.	M.
1	3	105	15	1	3	108	38	2	3	100	25
2	2	98	16	2	2	100	22	3	1	95	56
3	1	91	49	3	1	93	54	viii	iv	89	21
viii	iv	85	20	viii	iv	87	21	1	3	82	47
1	3	78	56	1	3	80	52	2	2	76	20
2	2	72	42	2	2	74	31	3	1	70	07
3	1	66	45	3	1	68	25	ix	iii	64	12
ix	iii	61	04	ix	iii	62	38	1	3	58	38
1	3	55	46	1	3	54	13	2	2	53	26
2	2	50	49	2	2	52	08	3	1	48	37
3	1	46	14	3	1	47	25	x	ii	44	08
x	ii	41	58	vi		43	03	1	3	39	49
1	3	38	01	1	3	39	00	2	2	36	11
2	2	34	20	2	2	35	16	3	1	32	37
3	1	30	55	3	1	31	46	xi	i	29	19

(22)				(23)				(24)			
xi	i	27	43	xi	i	28	31	i	3	26	12
i	3	24	42	i	3	25	28	2	2	23	17
2	2	21	52	2	2	22	35	3	1	20	32
3	1	19	10	3	1	19	51	xii		17	53
xii		16	36	xii		17	16	1	3	15	25
1	3	14	07	1	3	14	47	2	2	13	02
2	2	11	44	2	2	12	23	3	1	10	42
3	1	09	26	3	1	10	04	i	xi	08	27
i	xi	07	10	i	xi	07	49	1	3	05	15
1	3	04	57	1	3	05	37	2	2	04	06
2	2	02	46	2	2	03	26	3	1	01	53
3	1	00	36	3	1	01	16	Sub-		stile.	
Sub-		stile.		Sub-		stile.		ii	x	00	13
ii	x	01	34	ii	x	00	52	1	3	02	26
1	3	04	38	1	3	03	01	2	2	04	36
2	2	05	56	2	2	05	09	3	1	06	46
3	1	08	10	3	1	07	26	iii	ix	08	54
iii	ix	10	26	iii	ix	09	39	1	3	11	09
1	3	12	47	1	3	11	57	2	2	13	29
2	2	15	12	2	2	14	23	3	1	15	54
3	1	17	43	3	1	16	47	iv	viii	18	25
iv	viii	20	19	iv	viii	19	21	1	3	21	04
1	3	23	06	1	3	22	03	2	2	23	51
2	2	26	00	2	2	24	52	3	1	26	48
3	1	29	06	3	1	27	95	v	vii	29	54
v	vii	32	24	v	vii	31	08	1	3	33	18
1	3	35	53	1	3	34	34	2	2	36	54
2	2	39	43	2	2	38	17	3	1	40	47
3	1	43	48	3	1	42	15	vi.		44	59
vi.		48	12	vi.		46	33	1	3	49	31
1	3	53	57	1	3	51	12	2	2	54	25
2	2	58	63	2	2	56	12	3	1	59	0'
3	1	63	31	3	1	61	34	vii	v	65	[illegible]
vii	v	69	18	vii	v	67	18	1	3	71	[illegible]

South Declining 25 00.				South Declining 26 00.				South Declining 27 00			
Hours.		D.	M.	Hours.		D.	M.	Hours.		D.	M.
2	2	103	28	2	2	106	33	1	3	108	35
3	1	98	00	3	1	100	06	2	2	102	10
viii	iv	91	47	viii	iv	94	21	viii	iv	95	31
1	3	84	45	1	3	86	45	1	3	88	46
2	2	78	13	2	2	81	53	2	3	82	02
3	1	71	53	3	1	73	43	3	1	75	28
ix	iii	65	49	ix	iii	67	27	ix	iii	69	09
1	3	60	07	1	3	62	10	1	3	63	10
2	2	54	48	2	2	56	08	2	2	57	33
3	1	49	51	3	1	51	04	3	1	52	20
x	ii	45	16	x	ii	46	22	x	ii	47	31
1	3	41	02	1	3	42	02	1	3	42	50
2	2	37	08	2	2	38	02	2	2	38	58
3	1	33	39	3	1	34	19	3	1	35	12
xi	i	30	07	xi	i	30	53	xi	i	31	41
1	3	26	58	1	3	27	43	1	3	28	27
2	2	24	09	2	2	24	42	2	2	25	24
3	1	21	16	3	1	21	53	3	1	22	28
	xii	18	33		xii	19	13		xii	19	51
1	3	16	04	1	3	56	02	1	3	16	39
2	2	13	39	2	2	13	37	2	2	14	14
3	1	11	20	3	1	11	19	3	1	12	31
1	xi	09	04	1	xi	09	40	1	xi	10	16
1	3	06	52	1	3	07	38	1	3	08	03
2	2	04	42	2	2	05	19	2	2	06	55
3	1	02	34	3	1	03	11	3	1	02	47
ii	x	00	02	ii	x	01	05	ii	x	01	40
Sub-		stile.		Sub-		stile.		Sub-		stile.	
1	3	01	40	1	3	01	01	1	3	01	23
2	2	03	47	2	2	02	33	2	2	02	28
3	1	05	58	3	1	05	15	3	1	05	34
iii	ix	08	08	iii	ix	07	24	iii.	ix.	07	42
1	3	10	22	1	3	09	35	1	3	09	51
2	2	12	41	2	2	11	51	2	2	11	09
3	1	15	03	3	1	14	11	3	1	13	22

(23)				(26)				(27)			
	viii	17	31	iv	viii	16	36	iv	viii	35	46
	3	20	32	1	3	19	08	1	3	18	13
	2	22	44	2	2	21	47	2	2	20	50
	1	25	47	3	1	24	36	3	1	23	34
	vii	28	47	v	vii	27	36	v	vii	26	29
	3	32	03	1	3	30	47	1	3	29	36
	2	35	34	2	3	34	13	2	2	32	57
	1	39	29	3	1	37	54	3	1	36	32
vi.		43	28		vi.	41	54		vi	40	26
	3	47	54	1	3	47	26	1	3	45	50
	2	52	41	2	2	52	13	2	2	50	31
	1	57	51	3	1	57	24	3	1	54	11
ii	v	63	24	vii	v	61	26	vii	v	59	33
	3	69	18	1	3	67	16	1	3	65	19

outh Declining 28 00				*South Declining* 29 00				*South Declining* 30 00			
	Hours.	d.	m		*Hours.*	d.	m.		*Hours.*	d.	m.
	1	104	15	3	1	106	21	3	1	108	25
iii.	iv.	97	36	viii.	iv.	99	42	viii.	iv.	101	47
	3	91	20	1	3	92	17	1	3	94	55
	2	84	01	2	2	86	00	2	2	88	00
	1	77	19	3	1	79	12	3	1	81	05
x.	iii.	70	52	ix.	iii.	72	36	ix.	iii.	74	21
	3	64	43	1	3	66	18	1	3	67	55
	2	58	58	2	2	60	24	2	2	61	52
	1	53	37	3	1	54	54	3	1	56	16
.	ii.	48	40	x.	ii.	49	50	x	ii.	51	00
	3	44	07	1	3	45	09	1	3	46	12
	2	39	57	2	2	40	52	2	2	41	48
	1	36	04	3	1	36	55	3	1	37	46
i.	i.	32	26	xi.	i.	33	16	xi.	i.	34	02
	3	29	10	1	3	29	50	1	3	30	37
	2	26	06	2	2	36	38	2	2	27	26
	1	23	12	3	1	23	50	3	1	24	27

(31)				(32)				(33)			
iv	viii	12	28	iv.	viii.	11	41	iv.	viii.	13	08
1	3	14	44	1	3	13	55	1	3	15	18
2	2	17	07	2	2	16	15	2	2	17	47
3	1	19	37	3	1	18	41	3	1	20	17
v	vii	22	15	v.	vii.	21	15	v.	vii.	22	58
1	3	25	04	1	3	22	00	1	3	25	49
2	2	28	04	2	2	26	56	2	2	28	52
3	1	31	18	3	1	30	04	3	1	32	11
	vi	34	48		vi.	33	29		vi.	35	46
4	3	38	36	1	3	38	19	1	3	39	40
2	2	42	43	2	2	41	12	2	2	43	57
3	1	47	15	3	1	45	35	3	1	48	38
vii	v	52	09	vii	v	50	24	vii	v	55	09
1	3	57	31	1	3	45	38	1	3	59	21
2	2	63	19	2	2	61	20	2	2	65	25

South Declining. 34 00.				South Declining. 35 00				South Declining. 36 00.			
Hours.		D.	M.	Hours.		D.	M	Hours.		D.	M
viii.	iv.	110	14	viii	iv	112	18	viii	iv	114	22
1	3	103	25	1	3	105	27	1	3	107	40
2	2	96	19	2	2	98	25	2	2	100	34
3	1	89	04	3	1	91	17	3	1	93	12
ix.	iii.	81	50	ix	iii	83	47	ix	iii	85	46
1	3	74	48	1	3	76	37	1	3	78	26
2	2	68	04	2	2	69	42	2	2	71	21
3	1	61	46	3	1	63	14	3	1	64	41
x.	ii.	55	56	x	ii	57	13	x	ii	58	32
1	3	50	35	1	3	51	42	1	3	52	51
2	2	45	42	2	2	46	41	2	2	47	39
3	1	41	14	3	1	42	07	3	1	43	00
vii.	v.	37	10	vii	v	37	57	vii	v	38	43
1	3	33	28	1	3	34	09	1	3	34	50
2	2	30	03	2	2	30	41	2	2	31	18
3	1	26	54	3	1	27	29	3	1	28	03
xii		23	56	xii		24	31	xii		25	04

(34)				(35)				(36)			
	3	21	16	1	3	21	46	1	3	22	16
	2	18	42	2	2	19	12	2	2	17	40
	1	16	17	3	1	16	46	3	1	17	13
	xi	14	00	i	xi	14	24	i	xi	14	54
	3	11	47	1	3	12	15	1	3	12	42
	2	09	40	2	2	10	08	2	2	10	35
	1	07	36	3	1	08	05	3	1	06	32
	x	05	36	ii	x	06	06	ii	x	08	32
	3	03	38	1	3	04	08	1	3	06	33
	2	01	41	2	2	02	19	2	2	04	37
ıb-		ſtile.		3	1	00	18	3	1	00	49
	1	00	15	Sub-		ſtile.		Sub-		ſtile.	
	ix	02	11	iii	ix	01	37	iii	ix	01	05
	3	04	09	1	3	03	34	1	3	02	58
	2	06	07	2	2	05	30	2	2	04	53
	1	08	08	3	1	07	29	3	1	06	50
	viii	10	12	iv	viii	09	31	iv	viii	08	49
	3	12	21	1	3	11	36	1	3	10	52
	2	14	34	2	2	13	47	2	2	13	00
	1	16	54	3	1	15	04	3	1	15	13
	vii	19	21	v	vii	18	27	v	vii	17	33
	3	21	57	1	3	20	58	1	3	20	00
	2	24	43	2	2	23	40	2	2	22	38
	1	27	10	3	1	26	34	3	1	25	27
ıi.		30	54		vi.	29	41		vi.	28	29
	3	33	56	1	3	33	04	1	3	31	46
	2	38	11	2	2	36	46	2	2	35	21
	1	42	20	3	1	40	49	3	1	39	17
	v	46	55	vii	v	45	15	vii	v	43	36
	3	51	55	1	3	50	18	1	3	48	22
	2	57	24	2	2	55	30	2	2	53	36
	1	64	19	3	1	61	21	3	1	59	21

South Declining. 37 00.			South Declining 38 00.			South Declining. 39 00		
Hours.	D.	M.	Hours.	D.	M	Hours.	D.	M.
i 3	109	41	i 3	112	01	i 3	114	29
2 2	102	45	2 2	104	57	2 2	107	08
3 1	98	21	3 1	97	33	3 1	99	43
ix iii	87	49	ix iii	89	56	ix ii	91	52
i 3	80	21	i 3	82	20	i 3	84	18
2 2	73	06	2 2	74	55	2 2	76	43
3 1	66	15	3 1	67	52	3 1	69	28
x ii	59	53	x ii	61	17	x ii	62	42
i 3	54	02	i 3	55	15	i 3	56	29
2 2	48	42	2 2	49	46	2 2	50	44
3 1	43	52	3 1	44	49	3 1	45	28
xi i	39	30	xi i	40	18	xi i	41	06
i 3	35	32	i 3	36	15	i 3	36	56
2 2	31	55	2 2	32	33	2 2	33	06
3 1	28	37	3 1	29	11	3 1	29	44
xii	25	35	xii	26	04	xii	26	35
i 3	22	29	i 3	23	15	i 3	23	43
2 2	20	06	2 2	20	36	2 2	21	03
3 1	17	40	3 1	18	07	3 1	18	31
i xi	15	21	i xi	15	47	i x	16	12
i 3	13	09	i 3	13	34	i 3	13	59
2 2	11	02	2 2	11	28	2 2	11	52
3 1	09	00	3 1	09	26	3 1	09	51
ii x	07	01	ii x	07	08	ii x	07	53
i 3	05	05	i 3	05	34	i 3	05	58
2 2	03	12	2 2	03	41	2 2	04	00
3 1	01	20	3 1	01	50	3 1	02	18
Sub-	stile.		Sub-	stile.		Sub-	stile.	
iii ix	00	32	iii ix	00	01	iii. ix	00	28
i 3	02	24	i 3	01	52	i 3	01	20
2 2	04	17	2 2	03	53	2 2	03	10
3 1	06	13	3 1	05	35	3 1	05	00
iv viii	08	10	iv viii	07	30	iv viii	06	53
i 3	10	10	i 3	09	28	i 3	08	49

	(37)				(38)				(39)		
	2	11	14	2	2	11	00	2	2	10	48
	1	14	24	3	1	13	37	3	1	12	52
	vii	16	41	v.	vii.	15	51	v.	vii.	15	01
	3	19	40	1	3	18	09	1	3	17	18
	2	21	38	2	2	20	39	2	2	19	49
	1	24	21	3	1	23	18	3	1	22	17
vi		27	18		vi.	26	09		vi.	25	03
	3	30	29	1	3	29	15	1	3	28	03
	2	33	51	2	2	32	37	2	2	31	20
	1	37	47	3	1	36	19	3	1	34	54
i	v	42	00	vii	v	40	23	vii	v	38	51
	3	46	36	1	3	44	53	1	3	43	14
	2	51	43	2	2	49	52	2	2	48	05
	1	57	21	3	1	55	21	3	1	53	27
ii	iv	63	30	viii.	iv.	61	24	viii.	iv.	59	22

uth Declining.				*South Declining.*				*South Declining.*		
40 00.				41 00				42 00.		
ours.	*D.*	*M.*		*Hours.*	*D.*	*M.*		*Hours.*	*D.*	*M*
3	116	16	2	2	111	31	2	2	113	45
2	111	57	3	1	104	09	3	1	166	17
1	101	56	ix	iii	96	22	ix	iii	98	03
iii.	94	16	1	3	88	15	1	3	90	31
3	86	20	2	2	79	18	2	2	82	28
2	78	35	3	1	72	38	3	1	74	37
1	71	10	x	ii	65	24	x	ii	67	12
ii.	64	10	1	3	58	46	1	3	60	21
3	57	44	2	2	52	44	2	2	54	07
2	51	54	3	1	47	19	3	1	48	30
1	46	42	xi	i	42	27	xi	i	43	29
i.	41	53	1	3	38	06	1	3	27	52
3	37	37	2	2	34	10	2	2	34	58
2	53	45	3	1	30	36	3	1	31	19
1	30	16		xii	27	33		xii	28	0[illegible]
xii	27	03	1	3	24	30	1	3	25	0[illegible]

(40)				(41)				(42)			
i	3	24	10	2	2	21	46	2	2	22	16
2	2	21	27	1	3	19	12	3	1	19	43
3	1	18	57	i	xi	16	53	i	xi	17	22
i	xi	16	36	1	3	14	37	1	3	15	03
1	3	14	22	2	2	12	35	2	2	12	59
2	2	12	16	3	1	10	34	3	1	10	59
3	1	10	14	ii.	x.	08	38	ii.	x.	09	02
ii.	x.	08	17	1	3	06	46	1	3	07	11
1	3	06	28	2	2	04	53	2	2	05	23
2	2	04	34	3	1	03	11	3	1	03	36
3	1	02	45	iii.	ix.	01	25	iii.	ix	01	51
iii.	ix.	00	58	Sub-		ſtile.		1	3	00	03
Sub-		ſtile.		1	3	00	21	Sub-		ſtile.	
1	3	00	49	2	2	02	07	2	2	02	34
2	2	02	38	3	1	03	54	3	1	03	22
3	1	04	27	iv.	viii.	05	42	v.	viii.	05	08
iv.	viii.	06	17	1	3	07	32	1	3	06	57
1	3	08	10	2	2	09	26	2	2	08	43
2	2	10	07	3	1	11	24	3	1	10	42
3	1	12	08	v.	vii.	13	27	v.	vii.	12	43
v.	vii.	14	14	1	3	15	37	1	3	14	49
1	3	16	27	2	2	17	53	2	2	17	01
2	2	18	46	3	1	20	19	3	1	19	23
3	1	21	17	vi.		22	57	vi.		21	54
vi.		23	59	1	3	25	42	1	3	24	38
1	3	26	21	2	2	28	48	2	2	27	37
2	2	30	03	3	1	32	10	3	1	30	32
3	1	33	31	vii	v	35	52	vii	v	34	26
vii	v	37	41	1	3	39	58	1	3	38	25
1	3	41	35	2	2	44	33	2	2	42	51
2	2	46	18	3	1	49	38	3	1	47	49
3	1	51	33	viii	iv	55	19	viii	iv	53	20
viii	iv	57	20	1	3	61	35	1	3	59	29

(46)				(47)				(48)			
3	1	12	15	3	1	12	29	3	1	12	47
ii.	x	10	21	ii.	x.	10	37	ii.	x.	10	55
1	3	08	32	1	3	08	50	1	3	09	07
2	2	06	48	2	2	07	07	2	2	07	24
3	1	05	06	3	1	05	20	3	1	05	42
iii.	ix	03	26	iii.	ixi	03	47	iii.	ix.	04	08
1	3	01	46	1	3	02	12	1	3	02	33
2	2	00	10	2	2	00	35	2	2	00	58
Sub-		stile.		Sub-		stile.		Sub-		stile.	
3	1	01	27	3	1	01	01	3	1	00	23
iv.	viii.	03	05	iv.	viii.	02	30	iv.	viii.	02	09
1	3	04	48	1	3	04	11	1	3	03	45
2	2	06	25	2	2	05	52	2	2	05	21
3	1	08	10	3	1	07	31	3	1	06	59
v.	vii.	09	57	v.	vii.	09	18	v.	vii.	08	42
1	3	11	49	1	3	11	06	1	3	10	28
2	2	13	46	2	2	13	01	2	2	12	19
3	1	15	52	3	1	15	00	3	1	14	16
	vi.	18	06		vi.	17	11		vi.	16	21
1	3	20	29	1	3	19	27	1	3	18	35
2	2	23	05	2	2	20	00	2	2	21	00
3	1	25	55	3	1	24	44	3	1	23	38
vii	v	29	20	vii	v	27	42	vii	v	26	32
1	3	32	30	1	3	31	34	1	3	29	45
2	2	36	32	2	2	35	00	2	2	33	21
3	1	40	43	3	1	39	00	3	1	37	24
viii	iv	45	38	viii	iv	43	54	viii	iv	41	54

South Declining. 40 00.				*South Declining.* 50 00.				*South Declining.* 51 00.			
Hours.		*D.*	*M.*	*Hours.*		*D.*	*M.*	*Hours.*		*D.*	*M.*
ix	iii	115	10	ix	iii	117	22	ix.	iii.	118	0[illegible]
1	3	107	46	1	3	109	14	1	3	111	43
2	2	97	50	2	2	91	08	2	2	100	52
3	1	88	53	3	1	81	48	3	1	93	2[illegible]

(43)				(44)				(45)			
1	2	16	11	2	2	15	19	2	2	14	
3	1	18	28	3	1	17	37	3	1	19	
	vi	20	55		vi	19	56		vi	19	
1	3	23	32	1	3	22	30	1	3	21	
2	2	26	34	2	2	25	18	2	2	24	
3	1	29	32	3	1	28	20	3	1	27	
vii	v	33	02	vii	v	31	38	vii	v	30	
1	3	36	52	1	3	35	26	1	3	33	
2	2	41	10	2	2	39	33	2	2	37	
3	1	45	58	3	1	44	14	3	1	42	
viii	iv	51	22	viii	iv	49	29	viii	iv	47	

South Declining. 46 00				South Declining. 47 00				South Declini 48 00			
Hours.		D.	M.	Hours.		D.	M.	Hours.		D.	
3	1	116	39	1	3	116	57	1	2	117	
ix	iii	108	50	ix	iii	109	00	ix	ii	117	
1	3	99	34	1	3	101	51	1	3	104	
2	2	90	58	2	2	93	21	2	2	95	
3	1	86	20	3	1	84	25	3	1	86	
x	ii	73	58	x	ii	75	56	x	i	77	
1	3	66	10	1	3	67	31	1	3	69	
2	2	58	58	2	2	60	17	2	2	61	
3	1	53	09	3	1	53	58	3	1	54	
xi	i	46	49	xi	i	47	39	xi	i	48	
1	3	41	41	1	3	43	22	1	3	43	
2	2	37	18	2	2	37	51	2	2	38	
3	1	33	19	3	1	33	50	3	1	34	
	xii	29	46		xii	30	11		xii	30	
1	3	26	35	1	3	25	56	1	3	27	
2	2	23	41	2	2	24	00	2	2	24	
3	1	21	03	3	1	21	20	3	1	21	
i	xi	18	37	i	xi	18	52	i	xi	19	
1	3	16	21	1	3	16	23	1	3	16	
2	2	14	15	2	2	14	32	2	2	11	

(46)				(47)				(48)			
	1	12	15	3		1	12	29	3		1	12	47	3
x	1	10	21	ii.	x	1	10	37	ii.	x	1	10	55	ii.
	3	08	32	1		3	08	50	1		3	09	07	1
	2	06	48	2		2	07	07	2		2	07	24	2
	1	05	06	3		1	05	22	3		1	05	42	3
i. ix		03	26	iii.	ix		03	47	iii.	ix		04	08	iii.
	3	01	46	1		3	02	12	1		3	02	33	1
	2	00	10	2		2	00	35	2		2	00	58	2
Sub-		stile.			Sub-		stile.			Sub-		stile.		
	1	01	27	3		1	01	01	3		1	00	23	3
: viii		03	05	iv.	viii		02	30	iv.	viii		02	09	iv.
	3	04	48	1		3	04	11	1		3	03	45	1
	2	06	25	2		2	05	52	2		2	05	21	2
	1	08	10	3		1	07	31	3		1	06	59	3
, vii		09	57	v.	vii		09	18	v.	vii		08	42	v.
	3	11	49	1		3	11	06	1		3	10	28	1
	2	13	46	2		2	13	01	2		2	12	19	2
	1	15	52	3		1	15	00	3		1	14	16	3
vi.		18	06		vi.		17	11		vi.		16	21	
	3	20	29	1		3	19	27	1		3	18	35	1
	2	23	05	2		2	20	00	2		2	21	00	2
	1	25	55	3		1	24	44	3		1	23	38	3
ii	v	29	20	vii		v	27	42	vii		v	26	32	vii
	3	32	30	1		3	31	34	1		3	29	45	1
	2	36	32	2		2	35	00	2		2	33	21	2
	1	40	43	3		1	39	00	3		1	37	24	3
iii	iv	45	38	viii		iv	43	54	viii		iv	41	54	viii

uth Declining. 40 00.				*South Declining.* 50 00.				*South Declining.* 51 00.			
Hours.		*D.*	*M.*	*Hours.*		*D.*	*M.*	*Hours.*		*D.*	*M.*
:	iii	115	10	ix	iii	117	22	ix.	iii	118	0[illegible]
	3	107	46	1	3	109	14	1	3	111	43
	2	97	50	2	2	91	08	2	2	100	52
	1	88	53	3	1	81	48	3	1	93	2[illegible]

(49)				(50)				(51)			
x	ii	79	43	x	ii	81	48	x	ii	83	15
1	3	71	04	1	3	72	49	1	3	74	57
2	2	63	02	2	2	64	30	2	2	65	59
3	1	55	47	3	1	57	02	3	1	58	14
xi	i	49	30	xi	i	50	25	xi	i	51	20
1	3	43	52	1	3	44	49	1	3	45	22
2	2	39	03	2	2	39	35	2	2	40	07
3	1	34	46	3	1	35	13	3	1	35	40
	xii	30	58		xii	31	21		xii	31	45
1	3	27	36	1	3	27	55	1	3	28	13
2	2	24	36	2	2	24	52	2	2	25	03
3	1	21	54	3	1	22	07	3	1	22	18
i	xi	19	23	i	xi	19	36	i	xi	19	49
1	3	17	02	1	3	17	20	1	3	17	32
2	2	14	59	2	2	15	11	2	2	15	25
3	1	13	01	3	1	13	14	3	1	13	25
ii	x	11	13	ii	x	11	27	ii	x	11	36
1	3	09	20	1	3	09	46	1	3	09	57
2	2	07	40	2	2	07	57	2	2	08	12
3	1	06	21	3	1	06	27	3	1	06	41
ix	iii	04	30	iii	ix	04	54	iii.	ix.	04	59
1	3	02	53	1	3	03	12	1	3	03	30
2	2	01	19	2	2	01	41	2	2	01	59
Sub-		stile.		3	1	00	10	3	1	00	35
3	1	00	15	Sub-		stile.		Sub-		stile.	
iv	viii	01	47	iv	viii	01	19	iv	viii	00	58
1	3	03	18	1	3	02	50	1	3	02	25
2	2	05	00	2	2	04	22	2	2	03	45
3	1	06	27	3	1	05	56	3	1	05	27
v	vii	08	00	v	vii	07	32	v	vii	07	00
1	3	09	49	1	3	09	12	1	3	08	36
2	2	11	37	2	2	10	57	2	2	10	18
3	1	13	32	3	1	12	47	3	1	12	05
	vi.	15	32		vi.	15	03		vi.	14	04
1	3	17	42	1	3	16	49	1	3	15	59
2	2	20	01	2	2	19	03	2	2	18	08
3	1	23	01	3	1	21	30	3	1	20	29
vii	v	25	37	vii	v	24	11	vii	v	23	07

(49)				(50)				(51)			
	3	28	27	1	3	27	19	1	3	25	59
	2	31	55	2	2	30	29	2	2	27	07
	1	35	49	3	1	34	14	3	1	32	43
i	iv	40	11	viii	iv	37	56	viii	ix	36	56

uth Declining. 52 00				South Declining 53 00				South Declining. 54 00			
Hours.	D.	M.		Hours.	D.	M.		Hours.	D.	M.	
	3	117	21	1	3	118	10	1	3	119	08
	2	106	27	2	2	108	05	2	2	110	46
	1	96	57	3	1	98	30	3	1	101	06
	ii	86	09	x	ii	88	35	x	ii	90	46
	3	76	27	1	3	78	29	1	3	80	40
	2	67	29	2	2	69	30	2	2	71	00
	1	59	22	3	1	60	40	3	1	62	05
i	i	52	10	xi	i	55	20	xi	i	56	26
	3	45	57	1	3	46	41	1	3	48	15
	2	40	40	2	2	41	10	2	2	42	30
	1	35	58	3	1	36	30	3	1	37	45
xii		32	05	xii		32	2[illegible]	xii		32	46
	3	28	24	1	3	28	39	1	3	28	56
	2	25	13	2	2	25	25	2	2	25	40
	1	22	24	3	1	22	3[illegible]	3	1	22	50
	xi	19	53	i	xi	20	12	i	xi	20	22
	3	17	38	1	3	17	45	1	3	17	56
	2	15	30	2	2	15	41	2	2	15	49
	1	13	35	3	1	13	43	3	1	13	59
l.	x.	11	48	ii	x	11	57	ii.	x.	12	06
	3	10	00	1	3	10	08	1	3	10	21
	2	08	21	2	2	08	38	2	2	08	43
	1	06	44	3	1	07	00	3	1	07	16
i	ix	05	18	iii	ix	05	31	iii	ix	05	44
	3	03	47	1	3	04	18	1	3	02	15
	2	02	18	2	2	02	35	2	2	02	52
	1	00	52	3	1	01	11	3	1	01	30
ub-		stile.		Sub-		stile.		viii	iv	00	0

(52)				(53)				(54)			
iv	viii	00	34	iv	viii	00	12	Sub-		ftile.	
1	3	02	00	1	3	01	36	1	3	01	14
2	2	03	28	2	2	03	02	2	2	02	37
3	1	04	46	3	1	04	32	3	1	04	00
v	vii	06	28	v	vii	05	56	v	vii	05	28
1	3	08	03	1	3	07	27	1	3	06	55
2	2	09	40	2	2	09	03	2	2	08	27
3	1	11	23	3	1	10	46	3	1	10	03
	vi.	13	13		vi.	12	26		vi	11	46
1	3	15	10	1	3	14	17	1	3	13	35
2	2	17	18	2	2	16	18	2	2	15	30
3	1	19	30	3	1	18	13	3	1	17	36
vii	v	22	00	vii	v	20	53	vii	v	19	50
1	3	24	44	1	3	23	30	1	3	22	23
2	3	27	53	2	2	26	26	2	3	25	13
3	1	31	01	3	1	29	42	3	2	18	20
viii	iv	35	34	viii	iv	33	33	viii	iv	32	00

South Declining 55 00				*South Declining* 56 00				*South Declining* 57 00			
Hours.		d.	m	*Hours.*		d.	m	*Hours.*		d.	m.
1	3	120	02	1	3	122	20	1	3	124	10
2	2	113	20	2	2	116	02	2	2	118	58
3	1	103	34	3	1	106	32	3	1	109	24
x.	ii.	93	24	x.	ii.	96	13	x	ii.	98	55
1	3	82	55	1	3	85	20	1	3	87	56
2	2	72	47	2	2	74	52	2	2	76	58
3	1	63	30	3	1	65	13	3	1	66	47
xi.	i.	55	25	xi.	i.	56	40	xi.	i.	57	50
1	3	48	21	1	3	49	20	1	3	50	10
2	2	42	22	2	2	43	02	2	2	43	40
3	1	37	18	3	1	37	50	3	1	38	12
	xii	33	06		xii	33	24		xii	33	42
1	3	29	10	1	3	29	21	1	3	29	28
2	2	25	52	2	2	26	02	2	2	26	15

(55)				(56)				(57)			
	1	22	57	3	1	23	05	3	1	23	10
	xi	20	23	i	xi	20	30	i	xi	20	33
	3	18	04	i	3	18	10	i	3	18	16
	2	15	56	2	2	16	03	2	2	16	09
	1	14	00	3	1	14	10	3	1	14	15
	x	12	13	ii	x	12	17	ii	x	12	21
	3	10	39	1	3	10	46	1	3	10	42
	2	08	53	2	2	09	07	2	2	09	10
	1	07	22	3	1	07	31	3	1	07	35
	ix	05	53	iii	ix	06	00	iii	ix	06	08
	3	04	30	1	3	04	43	1	3	04	45
	2	03	07	2	2	03	22	2	2	03	33
	1	01	45	3	1	02	02	3	1	02	18
	viii	00	26	iv	viii	00	41	iv	viii	01	02
Sub-		stile.		Sub-		stile.		Sub-		stile.	
	3	00	54	1	3	00	34	1	3	00	14
	2	02	14	2	2	01	53	2	2	01	30
	1	03	35	3	1	03	12	3	1	02	47
	vi	04	02	v	vii	04	33	v	vii	04	06
	3	06	26	1	3	05	55	1	3	05	26
	2	07	57	2	2	07	22	2	2	06	49
	1	09	26	3	1	08	50	3	1	08	15
vi.		11	05	vi.		10	24	vi.		09	44
	3	12	51	1	3	12	09	1	3	11	22
	2	14	38	2	2	13	50	2	2	13	08
	1	16	38	3	1	15	45	3	1	14	57
i	v	18	50	vii	v	17	52	vii	v	16	35
	3	21	16	1	3	20	10	1	3	19	10
	2	24	01	2	2	21	43	2	2	21	38
	1	27	02	3	1	25	37	3	1	24	22
ii	iv	30	30	viii	iv	28	54	viii	iv	27	30

The Second Part.

CHAP. I. *Fig.* 10.

How to make a Polar Dial.

A *Polar-Dial* is a Dial that lieth upon the Equinoctial Circle, whose Stile or Axis is 90 deg. high, or (more properly speaking) is Perpendicular to the *Plane*, and is the easiest to be made of any Dial whatsoever; for the Equinoctial *Circle* being divided into 360 deg. one 24 part is 15 deg. or one Hour; this Dial being an *Horizontal Dial* under the Poles of the World, where the Sun is said to move equal Space in equal Time; but the Shadow in all other Places is Irregular.

Therefore the making of this Dial is nothing but dividing a Circle into 24 equal parts, and setting up an Iron Pin perpendicular to its *Plane*, your Dial is finished.

And this *Plane*, or *Dial* is capable of receiving all the 24 Hours, in the Latitude of 90 deg. Because the *Sun* keepeth continually moving round it, and round it again for the space of almost half a Year: And in all other Latitudes according to the length of their Days: So in our Latitude are put on all the Hours from 4 in the Morning till 8 at Night.

But the making of this *Dial* according to *Geometrical Rule* is said down in Chap. 7. p. 21.

CHAP.

CHAP. II.

Of Vetrical *or* Horizontal *Planes, Arithmetically.*

IN these Planes there is nothing required but the *Height of the Pole above the Plane*, which in all Places, is equal to the Latitude of the Place, for which the Dial is made.

First, Therefore prepare a Table, according to the Example adjoyning, wherein set down all the Hours in order from 12, as they are equidistant from the *Meridian*, viz. 11 and 1, 10 and 2, 9 and 3, 9, *&c.* unto them adjoyn the Equinoctial Distances, that is, for the first Hour 15 Degrees, for the second Hour 30 deg. for the 3d Hour 45 deg. and so of the rest, by continual addition of 15 deg. then take out of your Canon (or Tables) upon a loose Paper, the Logarithm or Artificial Sign of the Elevation of the Pole above this Plane, which for 51 deg. 30 min. The Height of the *Pole* here at *London*, is 9,893544, and is always one of the middle Proportionals, in finding out every Hours distance, apply it to 9,428052, the Logar. tangent of 15 deg. (which is the first Hours Equinoctial distance) and add them both together, there shall come forth a new Logar. tangent of 19,321596, for that Hours distance, which set down in the *Table* by 15 d. in the same place, remove your *Paper*, to the Logar. tangent of 30 deg. and add them both together, you shall produce a new Logar. Tangent of 19,893544, for the Hour of 2 and 10, which set down in the *Table* by 30 deg. work after the same

manr

manner, with the Logar: Tangent of 45, 75 deg. for the rest of the Hours.

Hours:	Equinoctial distances.	The Logarithm of the Tangents.	The new Logar. of the Tangents.	The t hour distanc upon t Plan
XII.	d o o′	0	0	0d
XI I	15 0	9,428052	19,321596	11
X II	30 0	9,761439	19,654982	24
IX III	45 0	10,000000	19,893544	38
VIII IV	60 0	10,138561	10,132105	53
VII V	75 0	10,571947	10,465491	71
VI.	93 0	Infinite.	Infinite.	90

The Height of the Stile 51 deg. 30 min

The Canon for Calculation is,

As the Sine of 90 deg.
Is to the Sine of the Latitude, 51 deg. 30 m
So is the Tangent of 15 deg. (the *Equin Distance* of one Hour of 30 deg. for two H of 45 deg. for three Hours, *&c.*

To the *Tangent* of 11 deg. 50 min. for 11 1—of 24 deg. 20 min. for 10 and 2—c deg. 3 min. for 9 and 3, *&c.*

Now if you design to put into this Dia any of the rest that follow, the half Hour Quarters, their Distances upon the Plane a easily found by the same Rules, as the H were, for by adding the Log. Sine of the H *of the Pole,* or Stile unto the Log. Tange

3 deg. 45 min. 7 deg. 30 min. and 11 deg. 15 min. which are the Equinoctial Distances of Half-Hours and Quarters, there will come forth the Log. Tangents of new Distances, proper to the Halfs and Quarters. *Note*, There is a Table of Equinoctial Distances for Hours, Halfs and Quarters in Page 31.

Note, Thus you have all the Hour-lines; but for the Drawing of it take the Directions of the 1 Chapter, in Page 15.

CHAP. III.

How to draw the Hour-lines *upon a Direct* South Dial *in the* Lat. *of* 51 *deg.* 30 *min.*

IT is almost needless to say any Thing concerning the marking of a Direct *South* Dial, for there is but little Difference between it and the Horizontal, only you must take Notice that this *Plane* respecteth the *South* Pole, which Pole is elevated thereon 38 deg. 30 min. (always) the Complement of the *Latitude*, therefore take 38 deg. 30 min. out of your *Scale* of Latitudes, and finish your *Dial* in all Respects as you did the Horizontal: But observe, that whereas in that *Dial*, the Hours of 1, 2, 3, *&c.* were set off on your Left-hand of the *Meridian*, so the same Hours must in this *Dial* be set off on your Right-Hand of the *Meridian*; if you well observe what was said in the IXth Chapter, Page 24.

Note, That the *Angle* which the *Stile* makes with the *Meridian*, must (as I have said before) *be 38 deg. 30* min.

2. And Lastly, That the *Stile* must f
right *Angles* with the Plane.

CHAP. IV.

Concerning a Direct North Dial.

A Direct *North* Dial, is the same with th
only the Stile must point upwards
the *North* Pole, and the hours about Mid-
9, 10, 11, 12: 1, 2, and 3 must be left ou
and 5 in the Morning, and 7 and 8 at Nig
be drawn thro' the Center, as in the *He*
Dial: So is your *North* Dial finished.

SECT. I.

How to draw an Horizontal Dial, *for the* 1
of 51. 30. *by the* Scale *of* Latitude, *a*
clination of the Meridian.

1. DRAW the Line A B, for 6 a Cloc
ing and Evening.

2. Draw NS, Perpendicular to A B; t
shall be the Meridian, or 12 a Clock He

3. Let C, the Intersection of the foresa
be the Center of the *Dial*; then repair
Scale of Latitudes, and fixing one Foo
Compasses at the beginning, extend the
51 deg. 30 min. and set that from C to
from C to B, then open your Compa
whole length of the line of *Inclination*, or
of 90 deg. setting that extent one Foot in
the other till it meet with the Meridian
as at O, and draw the Line A O, and

4. *This* done, extend your Compass

beginning of your Scale of 90 deg. to 15 deg. an
set from O towards A and B, for the Hours o
11 and 1, also from A towards O, for 5 a Clock
and from B towards O, for 7 a Clock. Then ex
tend your Compasses from the beginning of you
Scale to 30 deg. and set from O towards A, an
B, for the Hours of 2 and 10. Likewise from A
towards O, for 4, and from B, towards O, fo
8 of the Clock. Then take 45 deg. and set fron
O, toward A, and B, for the Hours of 3, an
9, so you have 12 Points for Hours. Now Line
drawn from the Center C, to each of those Point
shall be the Hours required.

Note, That the Hours of 4 and 5 in the Morning
and 7 and 8 in the Evening, must be drawn thro
the Center C; and if you design the halfs an
quarters of an Hour on your *Dial*, observe wha
was said in the last Chapter.

2. With a Line of Chord, make an Angle o
51. 30. for the Stile of your *Dial*, and set it ove
the Meridian-line C O at Right Angle, and you
Dial is finished.

CHAP. V. *Fig.* 21

How to draw Hour-lines upon a South *or* North Dia
Declining either East *or* West *to any Declination.*

BEFORE the Hour-lines can be drawn upo
any of those *Planes* two Things must b
given, and *three* other Things must be found
The Things given are,
1. The *Latitude* of the Place.

2. The *Planes Declination*,

The Things that must be found are,

1. The Substiles Distance from the *Mer* or 12 a Clock Hour-line.

2. The Height of the Stile above the *Pla*

3. The *Planes* difference of Longitude.

Example, Suppose that in the Latitude of *don* 51, 30, it were required to draw a *Di* deg. of *Declination Westwards*.

The Canon for Calculation are,

As the Radius ————	90 : 00	—10,00
Is to the Sign of the *Declinat.*	25 : 00	— 9,62
So is the Co-Tang. of the *Lat.*	51 : 30	— 9,90
To the Tan. of the Sub. dist.	18 : 33	—19,52

As the Radius ————	90 : 00	—10,00
Is to the Co-sign of the *Decli.*	25 : 00	— 9,95
So is the Co-sign of the *Lat.*	51 : 30	— 9,79
To the sign of the Stiles height,	34 : 21	—19,75

As the Radius ————	90 : 00	—10,00
Is to the Co-Tang. of the *Dec.*	25 : 00	—10,33
So is the Sign of the *Latitude*	51 : 30	— 9,89
To the Co-Tang. of the *Planes Long.*	30 : 47	—10,22

ring proceed-
us far prepare
ble of Hours
r the Plane,
s is here done.
n against XII.
e Planes Dif-
es of Longi-
o deg. 47min.
e second Co-
and from it
ct 15 deg. and
will remain
7, which set
t XI, and I,
subtract 15
here will re-
only 47 min.
set against
Then because
n. is less than

Hours on the East Dial	Hours on the West Dial	Equinoctial Distances. D.	M.	True Hours distance from the Substile D.	M.
III.	IX.	75	47	65	49
II.	X.	60	47	45	16
I.	XI.	45	47	30	07
XII.		30	47	18	33
XI.	I.	15	47	09	04
X.	II.	00	47	00	02
Substile		Substile		Substile	
IX.	III.	14	13	08	08
VIII.	IIII.	29	13	17	31
VII.	V.	44	13	28	47
VI.		59	13	43	27
V.	VII.	74	13	63	24
IV.	VIII.	86	13	88	37

g. write the word Substile under it, and
t it from 15 deg, there will remain 14 deg
n. which set against IX and III. Then
deg. 13 min. add 15 deg. it maketh 29 : 13.
set against VIII and IV. Then add 15 deg.
eth 44 : 47 which set against VII and V.
add 15 and it makes 59 : 47 which set a-
VI. then 15 more makes 74 : 47, which set
V and VII, then 15 more makes 89 :
ving finished your Table on this side of
lock, I begin again at 12 and add
s 45 : 47, which set against I. and

and 15 more makes 60: 47 which set against II and X, and 15 more makes 77: 47, which set against III and IX. And thus you have made a Table fit for Calculation, *viz.* for finding the true Hour-distances on the Plane.

The Canon for Calculation is,

As the Radius, — — —	90:00-	10,000000
Is to the sign of the Stiles height,	34:21-	9,751469
So is the *Tan.* of the *Equi.* dist.	14:13-	9,403718
To the *Tangent* of, — —	08:08-	19,155187

Which is the Distance of 9 and 3 of the Clock from the Substile.

And so will the *Tangent* of the next *Equinoctial* Distance, 29: 13, be to the *Tangent* of 17: 31, for the Distance of the Hour-line of 8, and 4, from the Substile, and so for all the rest of the Hours, as in the Table.

Having calculated all your Hours, you have Directions for describing them on the Plane, by Chap. V. Page 19.

SECT. I.

How to draw Hour-lines on South *or* North *Declining* Planes *by your Line of* Latitude *and Inclination of* Meridian *on your Ruler in Page* 62.

An Example of the foregoing *Dial*, *Decl.* 25 deg.

HAVING calculated your Requisites belonging to your Dial, and made a Table

E

ial Distances, according to the former
his Chapter, you will find them to be as
th,

Latitude.	51 — 30
Pl. Decli.	25 — 00
Sub. Dist.	18 — 33
Stiles Hei.	34 — 21
Plan. Long.	30 — 47

Hours.	*Equinoct*	
	D.	*M.*
IX.	75	47
X.	60	47
XI.	45	47
XII.	30	47
I.	15	47
II.	00	47
Sub-	stile.	
III.	14	13
IV.	29	13
V.	44	13
VI.	59	13
VII.	74	13
VIII.	89	13

draw the *Dial.*

)raw an *Horizontal*
i the *Plane.*
raw C 12, the *Me-*
r 12 a Clock Hour-
rpendicular to the
al-line of your *Plane,*
h a Line of Chords
e Angle FC 12. equal
bstiles distance from
dian, and draw CF
ubstile on the right-
the *Meridian* be-
e *Plane declines West.*
aw the Line AB,
ular to the Substile,
ng thro' the Center
en out of your line
de take 34 : 21 (the
of your Stile) and
om C to A, and
:o B, then take in your Compasses the
:ngth of your Scale of *Inclination* of *Me-*
nd set one Foot in A, and turn the o-
ut till it will touch the Substilar line, as
d draw the Line FA, and FB.
en repair to your Table, and take off
le of *Inclination* of Merid. 15 deg. 47 min

30 : 47, 45 : 47, 60 : 47, 75 : 47, and 1
F the Subſtile towards A, for the Hours
12, 11, 10, and 9 of the Clock; again t
13, 29 : 13, 44 : 13, 59 : 13, 74 : 13, a
13, and ſet from F, towards B, for the I
3, 4, 5, 6, 7 and 8: *Note*, 8 falling al
Horizontal-line, is drawn thro' the Cente
in the Morning, as you ſee in the Figur

5. Let your Hour-lines be drawn fr
Center thro' every mark in the Line F
FB, and your Stile ſet on the Subſtile, ma
Angle of 34 : 21, and your Dial is finiſh

SECT. II.

How by the Heigth of the Stile, the D
tion of the Sun, *to find what T*
Sun *ſhall part, from one ſide of a*
ing Plane *to the other.*

The Canon for Calculation.

As the Radius, —— —	90 : 00—10
Is to the *Tang.* of the *Sun's Decl.*	23 : 30— 9
So is the *Tang.* of the Stiles hei.	34 : 21— 9
To this Co-ſine, *viz.*	72 : 43—19
From which Subtract —— the *Planes Long.*	30 : 47
And there remains,	41 : 56

Which 41 : 56 reſolved into Time (by
ing 15 deg. to one Hour, and the odd
min. of Time,) maketh 2 Hours 48 mi
néon, that the Sun forſaketh the South

clining East, to shine upon the *North Dial Declining West*: So by the same Calculation the *Sun* forsaketh the *North Declining East* 2 Hours 48 min. before Noon, to Shine upon the *South Declining West*.

Again the *Sun* being in vs, the *Southern* Sine unto — — — — — — —	72—43
Add the *Planes Longitude* — — —	30—47
	102—90
The Sum is, — —	103—30
Whose Complement to 180 deg. is,	76—30

Which converted into Time is 5 Hours 6 min. or the Time in Capricorn, when the *Sun* passeth from one side of the *Plane* to the other, between which two Limets the Annual Variety of the Sun is concluded.

Lastly, In the making of this Dial you have made Four, *viz.* First a *South Declining West* 25 deg. but if you turn your Paper and look thro' it, it will on the Back-side be a *South Declining East*, 25 deg. Only the Afternoon Hours on the *West Dial*, must be the Morning Hours on the *East*, and if you turn your Dial the Bottom upwards, and reckon your Hours the contrary way: So a *South East Decliner*, will be a *North East Decliner*, and a *South West Decliner*, will be a *North West Decliner*, leaving out the Hour-lines (which will be needless) before the Sun-setting, and after the Sun-rising.

Note, That the Substile in all *Decliners*, goeth from the *Meridian* towards that Coast, which is *contrary to the* Coast of the Planes Declination.

How to draw Hour-lines *upon a* Fat *Declining* Dial, *by the two* Polar Scales *on the* Ruler.

Example of a South Dial Declining East 80 *deg. in the Latitude of* 51 *deg.* 30 *min.*

BY the Directions of the last Chapter (or by Page. 26) you shall find the Inclination of the *Meridian* to be 82 deg. 9 min. and the Height of the Stile above the Plane 6 deg. 12 min. and the Substile's Distance from the *Meridian* 38 deg. 4 min.

Proceed thus, draw first, the Perpendicular GH, then with the *Radius* of your Line of Chords, describe the Arch LM; and set off the Substile and Stile with the same Line of *Chords*, according to their respective Angles, and draw the pricked line CBA for the *Substile*; and GIK for the *Stile*.

Then choose any point in the *Substile*, as A, through which Point A, draw a Line at length, Perpendicular to it, as the Line EAC, that done fix one Foot of your Compasses at the beginning of your longest *Polar Scale*, and extend the other to the Hour of 3, set off this extent from A to C, and through the Point C draw a Line Parallel to the *Stile* GIK, as the Line CD, so shall CD be the *Stile* increased. Then open your Compasses from the beginning of your second or lesser *Polar Scale*, to 3 Hours, and with that extent, place one Foot of your Compasses in the Substile ABG, carry

ng it along the said Line, until the other Foot of he Compasses just touch the Line CD, and there nake a mark, as at B, through which mark B, raw a Line at length, and Parallel to the Line AC, as the Line DBF. Then considering the *nclination* of the *Meridian* was found to be 82 eg. 9 min. find it on the first *Scale*, or *Scale* of o deg. and against it on the first *Scale* you shall nd 5 Hours 29 Minutes, by which it appears hat the *Substile* falleth between the Hours of and 7 in the Morning.

Now according to the Inclination of Meridins 5 Hours 29 Minutes, you may proceed to nake a Table, and set off the Hours according-y, as followeth.

Open your Compasses too 00 *Hours* 29 min. of he greater *Polar Scale*, and set it for the Hour f 7, in the Line EAC. Then open the Compasses to 1 Hour 29 min. of the same *Scale*, and et it from A to 8. Then open your Compasses o 2 *Hours* 29 min. and set it from A to 9. Then pen your Compasses to 3 *Hours* 29 min. and set t from A to 10. Lastly, Open the Compasses *Hours* 29 min. and set it from A to 11.

Now having found the Points for the Hours on ne side of the *Substile* from A towards E, you nust do the like for the other *Hours* on the other ide of the *Substile*: And considering that the first Hour from the *Substile* towards E, namely, A , contains the Distance of 00 *Hours* 29 min. as y the following Table; the Complement there-f to 60 min. or an *Hour*, is 00 *Hours* 31 min. as he said Table appears.

Table

From A *towards* E.				*From* A *towa*		
H.	M.	H. on the Plane.		H.	M.	H. on t
0	29	*A*	7	0	31	*A*
1	29	*A*	8	1	31	*A*
2	29	*A*	9	2	31	*A*
3	29	*A*	10	3	31	*A*
4	29	*A*	11	4	31	*A*

Proceed to ſet off 00 *Hours* 31 min. tal the ſame *Polar Scale* from A to the *H* and extend your Compaſſes from the b of the *Scale* to 1 *Hour* 31 min. and ſet i to 5, alſo to 2 *Hours* 31 min. and ſet it f 4, alſo to 3 *Hours* 31 min. and ſet it fr 3; and laſtly, The extent of the Compa the beginning of the Scale to 4 *Hours* 3 off from A to 2, and ſo you have Poin the Hours on the Plane on the Line C*A*

Now for the other Line DBF, you m the Hours thereon (taken out of the *le Scale*) from B both ways according to t in all Reſpects as you did ſet off the *H* A. This being done, draw Lines throug ſpective Points found in the Lines C DBF, and thoſe Lines ſhall be the H for this Dial.

The Stile muſt be a thin Plate of Iron, and ſtand directly over the Subſ the Figure is demonſtrated, by AB and

Thus have you finiſhed your Dial, a *making of this* you have made a South

80 deg. Also, for if you turn the Paper, look through it, it will on the back-side ap- *Declining West* 80 deg. only the Forenoon 's in this, must be the Afternoon *Hours* in that: , in rigour, you have in this one Dial made , a *North Declining*, either *East* or *West*.

CHAP. VII. *Fig.* 18.

to draw Hour-lines *upon a* direct East-Dial, *Arithmetically.*

ET there be an *East-Dial*, whose breadth is 6 Inches; and it is required to put on all Hour-lines from 6 in the Morning till 11 at on; here you have 5 Hours and 6 Inches: refore, before you can work the Operation, must turn the Hours into Degrees, by al- ing for every Hour 15 Degrees, so you will 75 Degrees for 5 Hours; then turn the nes into Parts, by allowing 100 Parts to y Inch, so you will have 600 Parts.

I. For the Height of the Stile.

the Radius 90	10,00000
the *Tangent* of 5 Hours 75 deg. com. A.	9,42805
the Log. of the distance from 6, 600 parts	2,77815
the Log. of the Stiles height, in Parts 161.	12,20620

That is, 1 Inch, 61 Parts of an Inch, an Inch ided into 100 Parts.

II. For the Hour-lines distance from VI.

7.	As the Radius 90.	10,000
	Is to the Log. of the Stiles height 161.	2,206
	So is the Tangent of 15 deg. for 7 a Clock	9,428
	To the Log. of the first Hour 43 Parts,	11,634
8.	As the Radius 90.	10,000
	Is to the Log. of the Stiles height 161.	2,206
	So is the Tangent of 30 deg. for 8 a Clock,	9,761
	To the Log. of the 2d Hour 43 Parts.	11,968
9.	As the Radius 90.	10,000
	Is to the Log. of the Stiles height 161.	2,206
	So is the Tang. of 45 deg. for 9 a Clock,	10,000
	To the Log. of the 3d Hour, 161 Parts.	12,206
10.	As the Radius 90	10,000
	Is to the Log. of the Stiles height 161.	2,206
	So is the Tang. of 60 deg. for 10 a Clock.	10,228
	To the Log. of the 4th Hour, 279 Parts.	12,434
11.	As the Radius 90	10,000
	Is to the Log. of the Stiles height 161.	2,206
	So is the Tang. of 75 deg for 11 a Clock,	10,594
	To the Log. of the 5th Hour, 600 Parts.	12,799

Having thus far proceeded, that 5 Hours fro 6 is calculated, namely, 7, 8, 9, 10, 11, the are yet 4 and 5 in the Morning that must b drawn the same distance from 6 in the Morning as 7 and 8 are; therefore for your better In struction, see the following Dial, and imita this Geometrical Construction.

First, Square out your Dial, and draw the Lin D,A,C, towards the bottom of your Plane; the *with 60 degrees* of Chords in the Point C, on th

ed

lge of the Dial, describe a part of a Circle as , B, and set from A, to B, the Complement of our Latitude 38°. 30' and draw the Line CBF, ıro' the Plane for the Equinoctial.

Secondly, Have Recourse to your Table, and ıke, in your Compasses, the distance in Parts etween 6 of the Clock and 11 namely 600, and ıake Marks with both Feet in the Equinoctial ır the Hour-lines of 6 in the Morning, and 11, ut remember to leave room above 6, for 4 and in the Morning, then take in your Compasses 3 Parts, and set from 6, to 7, and 5, then take ı your Compasses 93 Parts, and set in the Equaır or Equinoctial, from 6 to 8 and 4; then take ı your Compasses 161, and set in the Equinoctial om 6, to 9: Lastly, Take 279 Parts, and set in ıe Equinoctial from 6 to 10, and thro' the oints in the Equinoctial draw Perpendiculars, nd they shall be the true Hour-lines.

Note, The Stile must be the breadth of 6 and of the Clock, as you see in the Figure; and ıust stand perpendicularly in the Hour-line of of the Clock.

IV.	093
V.	043
VI.	000
VII.	043
VIII.	093
IX.	161
X.	279
XI.	600

Note, If you have a Mind to draw the Quarters and Half Hours, and Three Quarters, you may, if you observe what was said in Ch. 2. B. 69.

SEC

How to draw the Hour-lines, *upon a* Direct East *or* West Dial *instrumentally by the* Polar Scale.

1. UPON the Point C, if it be an *East-Dial*, or upon the Point D, if a *West*, with 60 deg. of your Line of Chords, draw an obscure part of a Circle as AB, and in that Arch from A to B, set off the *Height* of the *Equinoctial*, 38 deg. 30 min. and draw the Line CDE, then in some convenient Place of the Line CE, as at R, draw the Line GRF, at right Angles to the Line EDC, so shall GRF, be the Substile and Hour-line of 6.

2. Draw IH, parallel to the Line EDC.

3. Repair to either of your *Scales* known by the Letters [*Pol.*] and fix one Foot of your Compasses at the beginning of the said *Scale*, and extend the other Foot to the Hour of 1. Set off that extent from G to 5. and from G to 7, and on its parallel EC, from R both ways, and draw the Hours of 5 and 7 parallel to the Substile and Hour-line of 6: Then take in your Compasses the distance from the beginning of the Scale to 2 hours, and set it off from G to 4, and from G to 8, and also from R both ways, and draw the hour of 4 and 8 parallel to the other; so you have no more hours to set off towards I, being 4 is the hour of Sun-rising; but proceed to set off the rest of the hours towards H, as you did the other hours, taking in your Compasses the distances from the beginning of the *Scale* to 3, 4, and 5, and setting each distance off respectively from G towards H, at 9, 10, 11, and

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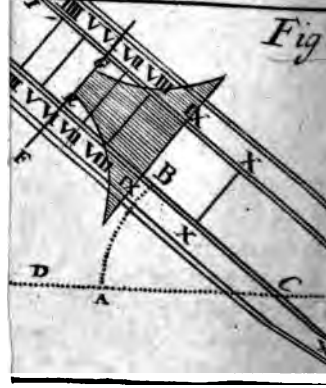
Fig. 14.

Fig. 16.



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from R towards C, and draw the hours of
o, and 11: And so you have all the hours
er for an *East-Dial.*

And lastly, The distance from the beginning
ne Scale to the hour of 3, gives the height of
tile, which must stand directly over the *Hour-*
of 6, make Right-Angles therewith, and may
ade of a thin Plate of Iron or Brass, or a
sharpned, whose Extremity must give the
ow to the *Hour-lines* on the *Dial.*

ote, That if you turn the *East-Dial* drawn on
r from you, and look on the back-side, you
see the perfect Form of a *West-Dial,* only
ad of the hours 11, 10, 9, 8, 7, 6, 5, 4,
must write 1, 2, 3, 4, 5, 6, 7 and 8.

CHAP. VIII.

ow to find the Reclination *of any* Plane.

AKE a *Quadrant* and joyn it to the side of a
Square, and place the other side of your
e to the *Plane*; if the *Plummet* fall Parallel
side of the *Square,* then the Lower-side of
uare stands level, by which draw a *Hori-*
-line, on which erect a *Perpendicular,* and
your *Square* to that *Perpendicular,* and if
lummet falls parallel to the side of the
, then that is also a Level-line, and your
stands *Horizontally:* If the *Plummet* falls
arallel to the side of the *Square,* then turn
Square until it does, then draw an Horizon-
; on which erect a Perpendicular to which
app

apply your *Square*, and observe what Angle your Plummet makes on the *Quadrant*, with the side of the *Square*, that is the Angle of the *Reclination* of the *Plane*.

CHAP. IX. *Fig.* 19.

Of *direct* East *or* West Reclining Dials, *and how* Hour-lines *may be described upon them.*

AS all Direct *North* and *South Reclining Dials* are reduced to *New-Latitudes*, wherein they would be *Horizontal* Dials; so all Direct *East* or *West Reclining* Dials, in any one Latitude, may be reduced to Upright Declining Dials in another Latitude.

Definition.] An *East* or *West Reclining* Dial, is a Dial that directly beholds the *East* or *West*, and Recline or fall back like the Roof of an *House*.

SECT. I.

To reduce any East *or* West Reclining Dial, *in any Latitude, to a* New-Latitude, *wherein the* Reclining Dial *shall become an* Upright Dial, *and what* Declination *that* Upright Dial *shall have in that* New-Latitude.

Example.

Suppose then, that a *direct East*, or *West* Dial in the *Latitude* of *London* 51—30; should recline from the *Zenith* 35 deg. in what Latitude will *that be* an Upright Dial? And what Declination *shall it have* in that Latitude?

RUL

RULE.

The Complement of the known Latitude, is (always) the New-Latitude; and the Complement of the Reclination is (always) the Declination in that New-Latitude.

So that if an *East* or *West* Dial should recline 35 deg. in the Latitude of 51—30, that will be an Upright Dial, Declining 55 deg. in the Latitude of 38—30.

For 38 : 30. being the Complement of 51 :30, is the New-Latitude. And 55 deg. being the Complement of 38:30 deg. the Dials Reclination is the Declination in that New-Declination.

The Canons for Calculation are,

I.

As the Radius	90,00—	10,00000
Is to the Sign of the Decli.	55:00—	9,91336
So is the *Co-Tang.* of the *Lat.*	38:30—	10,09939
To the Tan. of the Sub. diff.	45:52—	10,01275

II.

As the Radius	90:00—	10,00000
Is to the Co-sign of the Decli.	55:00—	9,75859
So is the Co-sign of the Lat.	38:30—	9,89344
To the sign of the Stiles height,	26,41—	19,65211

III.

As the Radius,	90:00	10,0000
Is to the Co-Tang. of the Decli.	55:00	9,8452
So is the Sign of the Latitude.	38:30	9,7941
To the Co-Tan. of the *Planes Long.*	66:27	19,6393

Hours.		*Equinoctial Distances.*		*True Hours on the Plane.*	
H.	*M.*	*D.*	*M.*	*D*	*M.*
10	02	83	33	75	50
09	03	68	33	48	49
08	04	53	33	31	18
07	05	38	33	19	41
06	06	23	33	11	04
05	07	08	33	03	52
Substile.					
04	08	06	27	02	54
03	09	21	27	10	00
02	10	36	27	18	21
01	11	51	27	29	24
12	12	66	27	45	52
11	01	81	27	71	29

Having calculated the *Requisites*, and made the Table after the manner of a declining Dial; and the Hour Arches calculated, we proceed to the Geometrical Projection of a West Recliner.

Draw the Line A,D, for the Horizontal-line of your reclining Plane; then at a convenient distance, and Parallel to the Line A,D, draw the Line G, O, 12, for the 12 a Clock Hour-line, and making G, the Center of your Dial, with 60 deg. of Chords, in G, describe the Circle O,R, p,d, and from O, to R, set the Substiles distance from the *Meridian* 45, 52 min. and from R to p, set 26, 41 the Stiles height, and draw R, G, for the Substile, and p, G, for the Stile; then take out of your Table 03:52, 11:04, 19:41, 31:18, 48:49, 75:50, and set from R, the Substile, for the hours of 5, 6, 7, 8, 9, and 10; likewise take 02:54, 10:00, 18:21, 29:24, 45:52, 71:29, and set for the hours of 4, 3, 2, 1, 12, 11, and thus you have all the hours as you see in *Fig.* 19.

SECT. II.

How to draw this Dial *by the* Line *of* Latitude *and* Scale *of* Inclination *of the* Meridian.

HAving found the Equinoctial Distance as before, and drawn the Horizontal-line, the Hour-line of 12, and set off the Substiles distance and Stiles height, proceed after this manner: Draw a Line perpendicular to the Substile, passing thro' the Center, as at G, and take off your line *of Latitude* 26 deg. 41 min. and set from G to *nd B; then* take the length of the whole Sc

of the Inclination of the *Meridian* in you
passes, and set one Foot in *a*, and turn th
about till it touch, or cross the Substile
and draw the Line *b*, *a*, and *b*, *b*, then re
your Table of Equinoctial Distances, and
your Scale of Inclination of *Meridian*
21:27, 36:27, 51:27, 66:27, 81:27, and
after another on the Line *b*, *a*, from *b* tow
for the hours of 4, 3, 2, 1, 12, and 11
Clock, then take 08:33, 23:33, 38:33,
68:33, 83:33, and place from *b* toward
the hours of 5, 6, 7, 8, and 9, of the C

Note, That 9 of the Clock is to be draw
the Center for the hour of 10 in the M
because the Sun shineth not in our Latit
13 min. after 8 at Night.

And thus you have at one Work made
viz. a *West Recliner* and an *East Recliner*,
West Incliner and an *East Incliner*, for if y
the Dial the bottom upwards, the Center
Northwards, and the *Axis* point Southwa
those Hours, *viz.* 3, 4, 5, 6, 7 and 8,
the Afternoon-hours of a *West* Inclining Di
if you observe the same of the *East* Re
Dial, it will produce the *East* Inclining I

Note, In the making of the *East* Re
Dial, your Center must be on the Left-ha
of the Plane, and the hours run the oth
as you may see if you turn your Dial, a
thro' the back-side of it.

SECT. II.

The Height *of the* Stile, *the* Declination *of the* Sun, *and the* Reclination *of the* Plane *given, to find what Time the* Sun *forsaketh the* East *or* West Reclining Dial, *and shineth on the opposite* Incliner.

Definition.

THE Planes of *East* and *West* Recliners or Incliners lie in the Circle of Position, denominating their Inclination; and to find the Time the *Sun* forsaketh the one to shine upon the other, observe this general Canon.

As the Radius	90.	10,00000
Is to the *Tang.* of the *Sun*'s Decl.	23:30	9,63830
So is the *Tang.* of the *Stiles* height.	26:41	9,70129
To the Co-sine of	77:22	19,33959
To which add the Planes *Long.*	66:27	
And the Sum is	143:49	
Whose *Complement* to 180 is	36:11	

Which 36:11 resolveth into Time, by allowing 15 deg. to an hour, and to every odd deg. 4 min. giveth 2 hours 24 min. after Noon when the *Sun* (in *Cancer*) forsaketh the *East* Reclining Dial 35, and illuminateth the Opposite, the *West* Inclining Dial, or it giveth 2 hours 24 min. before Noon, when the Sun parteth from the East Reclining Dial, and shineth upon the West Inclining Dial

2. Of North Recliners.

1. Variety. If a *North-Plane* in the Lat of 51 deg. 30 min. should recline from th *nith* 20 deg. In what Latitude will that b *Horizontal-Plane*?

The Reclination 20 deg. being less then Complement of the Latitude of *London*, 38 30 min. add the Reclination 20 deg. and the Latitude 38 deg. 30 min. together; their 59 deg. 30 min. is the New-Latitude: An *Horizontal-Dial* for that shall be a *North-* *Reclining* 20 deg. in the Latitude of 51 30 min.

2. Variety. If a *North-Plane* in the Lati of *London*, 51 deg. 30 min. should recline f the *Zenith* 75 deg. In what Latitude will a Plane be *Horizontal*?

The *Reclination* 75 deg. being greater 38 deg. 30 min. Add them together and make 113 deg. 30 min. which being above 90 take the Complement thereof to 180 deg. w is 66 deg. 30 min. And that is the New-Latit So that an *Horizontal-Dial* made for the Lati of 66 deg. 30 min. will be a *North-Plane Re ing* 75 deg. in the Latitude of *London* 51 30 min.

3. Variety. If a *North Plane* in the Lati of *London* 51 deg. 30 min. should recline f *the Zenith* thereof 51 deg. 30 min, In *Latitude* will such a Plane be Horizontal?

Here the Reclination 51 deg. 30 min. is o *the Latitude* of *London*; and the Sum

clination 51 deg. 30 min. and the Complement of the Latitude 38 deg. 30 min. Add together, their Sum is 90 deg. for the New-Latitude: and an Horizontal Dial made for that Latitude 90 deg. will be a *North Plane Reclining* 51 deg. 30 min. of the Latitude of *London*, and must be made by the Rules delivered in the 30th Chapter of this Book.

Note, That upon all *South Reclining Direct Dials*, if the *Reclination* be less than the Complement of the Latitude, the *South*-Pole is elevated; if equal to the Complement of the Latitude, neither Pole is elevated, but is an *Equinoctial*, and is made by Chap. VI. And if more than the Complement of the Latitude, the *North*-Pole is Elevated, and the Canter of the *Dial* is at the bottom. And upon the *North* Inclining less than an Equinoctial, the *North*-Pole, equal to an Equinoctial, neither Pole, and more than a Equinoctial the *South*-Pole.

Note, 2. That upon all *North Direct Reclining Dials*, the *North*-Pole; and on all Direct Inclining *Dials*, the *South*-Pole.

SECT. I.

The Height of the Stile, *the Declination of the* Sun, *and the Reclination of the* Plane *given, to find what Time the* Sun *shall forsake a* North *Inclining* Plane, *to shine upon a* South *Reclining* Plane, *opposite thereto.*

THere is six Varieties of North and South *Reclining* and *Inclining* Dials — And first

the three *South*, I. In that which reclines 20 de
being less than an Equinoctial, there are giv
the height of the Stile 18 deg. 30 min. the Decl
nation of the Sun 23 : 30, to find at what Ti
the Sun forsaketh the *North* Inclining Plane,
shine upon the aforesaid *South* Reclining 20 deg

As the Radius, —— —	90	00	10,0000
Is to the *Tan.* of the *Sun's Decl.*	23	30	9,6383
So is the *Tan.* of the *Stiles* heig.	18	30	9,5245
To this Co-sine, — —	81	38	19,1628

Subtract this 81 : 38, out of 90 deg. there wi
remain 8 deg. 22 min. which converted into Time
giveth 34 min. before 6 in the Morning, and afte
it at Night, when the Sun in Cancer departed
from the Inclining side of the Plane, and shined
on the Reclining and contrary.

2. Of that which reclines to the Pole, or equa
to the Complement of the Latitude; this Dia
lyeth in the six a Clock Hour-Circle, and there
fore the Case is plain, that the Sun always passe
from one side the Flat to the other just at Six o
the Clock; and from the 13th of *September*, t
the 10th of *March* (or the Sun's abode in th
Southern Signs) the Sun shines not at all upo
the reclining side.

3. In that which Reclines 60 deg. being mor
than an Equinoctial; there are given the Stile
height 21: 30, the Sun's Declination 23 : 30, t
find at what Time the Sun parteth with the No

ıclining Dial, to ſhine on the *South* Reclining
ppoſite thereto.

s the Radius,	90	00	10,00000
to the *Tan.* of the *Sun's Decl.*	23	30	9,63830
) is the *Tan.* of the *Stiles* heig.	21	30	9,59539
o this Co-ſine,	80	08	19,23369

Subtract this 80 : 08, out of 90, and their will ;main 09 : 52, which converted into Time giv-th 00 hours 39 min. before Six a Clock in the ſorning, and after ſix at Night, when the *Sun* ı Cancer departs from the Inclining ſide to illu-ıinate the oppoſite Recliner, and contrary. And ıus may you be ſatisfied for any other Declina-on of the Sun whatſoever.

SECT. II.

'he Height of the Stile, *the* Declination *of the* Sun, *and Reclination of the* Plane *being given, to find what Time the* Sun *forſaketh the* North *Reclining* Dial, *to ſhine upon the* South *Inclining* Dial.

IN *North* Direct *Recliners,* there are three Varieties which ſhall be ſpoke of as fol-ɔweth.

1. Of the *North Reclining* 20 deg. This Dial luring the *Sun's* Southern Declination, it only hines upon the Inclining ſide: But during his ıbode in *the Northern* Sines, ſome part of the

Da

Day on the Reclining side, and some part
Inclining side; whose Quantity of time is
by the following Proportion.

As the *Radius* —— —— ——	90.00.	10.
Is to the *Tang.* of the Sun's decl.	23.30.	9.
So is the *Tang.* of the Stile height,	58.30.	10.
To this Co-sine of —— ——	44.48.	19.

Which 44.48, resolved into time, gi
hours 59 min. before, and after Noon, wh
Sun in *Cancer* forsaketh, and returneth a
the reclining part of the *Plane*.

2. Of the North Reclining 51.30. bein
lar Dial: This Dial lying in the Equi
Circle, hath the Sun during his abode
Nothern Sines, shining only on the reclining
and the Sun in the *Southern Sines* shines up
Inclining Dial.

3. Of the North Reclining 75 deg. bein
than a *Polar*: This Dial, during the Sun'
in the Northern Sines, hath the Sun only
on the Reclining Dial; the rest of the
shineth upon both (whose time is easily fo
the Declination) until the *Meridional* r
the Sun from the *Zenith* (or the *Zenith*
which is all one) be greater than the *R*
of the *Plane*, and then it shineth only u
Inclining Plane.

To find the time of the Year for that,
the Reclination of the Equinoctial 51
the Reclination of the Plane 75, and

remain 23.30. the Declination of the Parallel in which the Plane lieth, which is the first degree of *Capricorn*, (as you will find by Calculation) for at that time which is the 10*th* of *December*, the Sun forsaketh the Reclining Plane to shine only on the Inclining Dial, as you will find by the following Proportion.

As the Sine of the Sun's Decl.	23.30.	9. 60069
Is to the Radius ——— ——— ———	90.00.	10 00000
So is the Sine of the Difference	23.30.	9. 60069
To this *Sine* ——— ——— ———	90.00.	10.00000

Which is the third *Sign* from *Libra*, namely *Capricorn*, (as I said before) when it forsaketh the reclining *Dial*, to shine only upon the Inclining *Dial*, and so continues till it ascends again to *Cancer*, which is the Paralellisme with it, which is the 10*th* of *June*.

I have chose this *Dial*, reclining 75 deg. because the Operation, or Working, may seem difficult, because the first term 23.30, which must always be subtracted from the third, (which is 23.30,) the remainder is 90.00.

I shall here give you the Working of the Canon for a *Dial* reclining but 70 deg.

Example.

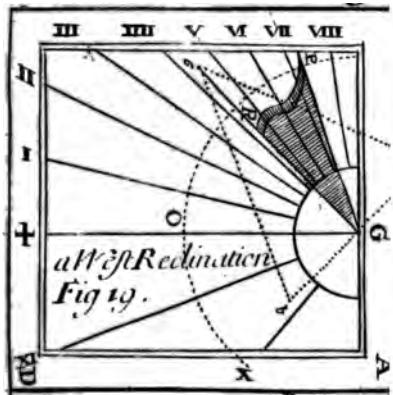
As the sine of the *Sun*'s Decl.	23.30.	9. 60069
Is to the Radius — — —	90.00.	10.00000
So is the sine of the Difference,	18.28.	9. 50072
To this sine	52.33.	9. 89973

Out of 52: 33, subtract 30 deg. for the sine *Libra*, there will remain 22. 33, of *Scorpio* for the place of the Sun, when it forsaketh the reclining *Dial*, to shine only on the Inclining *Dial*, till it ascend again into 07: 27, of *Aquaries*, which is in Parallelisme with it, by this place of the Sun every Almanack will shew the time of the Year.

Note also, That in making of any of these *North* or *South*, reclining *Dials*, you have made also a Direct North or South Dial inclining from the *Zenith* towards the Horizon, so many Degrees as the { Recli- / Incli- } nation.

So that when you have made a South-Dial reclining from the *Zenith* 60 deg. (as II the second Variety of *South* recliners in this Chapter) you have also a *North* Dial *Inclining* to the *Horizon* 60 deg. either by drawing the Hour-lines and Stile through the *Center*, or by turning the Reclining Dial about upon the Hour-line of VI. And then as the *North* Pole is Elevated upon the *South* recliner; so much will the *South* Pole be Elevated above the *North* Incliner, *&c.*

Of



a West Declination
Fig 19.

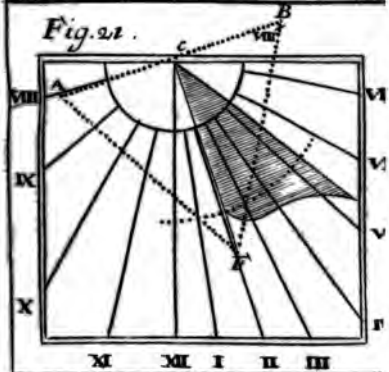


Fig. 21.

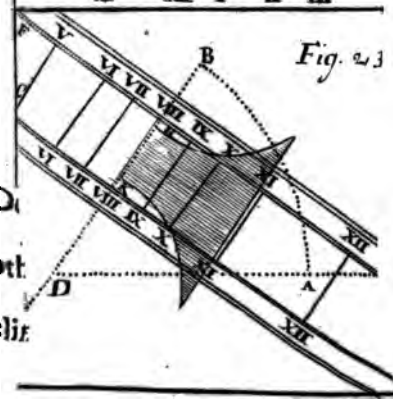


Fig. 23

f *Declining* and *Reclinin*
PLANES.

CHAP. XI.

S there were ſix Varieties of Direct *Nort* and *South* reclining Planes, ſo alſo ar ir of *South* and *North* Declining reclinin nes, *viz.* Three Varieties of *South* recliner lining, and as many of *North* recliners decli- g.

Of South *Recliners Declining* Planes.

. The Declination may be ſuch, that the re- ing Plane, ſhall interſect the *Meridian* be- en the *Zenith* of the Place, and the Pole of World.

I. The Declination may be ſuch, that the *b* reclining Plane, may fall upon the *Me- n* juſt upon the Pole-point; and ſuch Recli- g Declining Planes, are called Equinoctial cliners.

II. The Declination may be ſuch, that the *b* Decliner may fall between the Pole of the rld, and the Horizon.

These are the three Varieties of *South* recliners clining.

n *North* Decliners reclining, there are three r Varieties.

. *The Declination* may be ſuch, that the *ng Plane*, may cut the *Meridian*, betw

II. The Declination may be ſuch, that the *Orth* reclining declining Plane, may croſs the *Meridian* in the Point where the Equinoctial cut it—And ſuch Planes are called Polar declining Planes, becauſe the Poles of them lie in the Axis o the World, and the Subſtile in ſuch Planes, will be always Perpendicular to the *Meridian* of tle Place.

III. The Declination may cauſe the reclining Plane to cut the *Meridian*, between the Equinoctial and the Horizon.

Examples of all theſe Varieties follow.

I. *Of South Recliners.*

The Firſt Variety.

CHAP. XII. *Fig.* 24.

To draw Hour-lines, *upon a* South *Reclining Plane Declining* Eaſt *or* Weſt, *which paſſeth between the* Zenith *and the* Pole.

Example.

LET the Lat. of the Place be *North*, 51 30
The Decl. of the Plane be *Eaſt*, 20 00
The reclination of the Plane be 20 00

I. To find the New-Latitude, wherein the *Plane ſtands* as an upright Decliner.

The Canon for Calculation,

As the Radius	90	00	10,00000
Is to the Co-ſine of the old Decl.	20	00	9,97248
So is the Co-Tang. of the Recl.	20	00	10,43843
To the Tangent of	68	49	10,41151
The *Lat.* of the place Subtracted	51	30	
There remains	17	19	

Whoſe Complement 72.41, is the *New-Latitude.*

II. The referring of this Plane to a new-Latitude, doth alter the *Declination* alſo; therefore a New-Declination muſt be found.

The Canon for Calculation,

As the Radius	90	00	10,00000
Is to the Co-ſine of the *Recl.*	20	00	9,97298
So is the ſine of the old-Decl.	20	00	9,53405
To the ſine of the new-Decl.	18	45	19,50703

Having found the New Latitude and Declination, you may find the Subſtiles diſtance, the Stiles height, and the *Planes* difference of Longitude, by the Chapter, which are as followeth.

The height of the Pole above the *Horiz.*	51	30
The Planes old Declination,	20	00
The Reclination	20	00
The Planes New Latitude	72	41
The Planes New Declination	18	45
The Subſtiles diſtance from the *Meridian,*	05	43
The Stiles height.	16	23
The Planes difference of Longitude,	19	34

Having found the Longitude and reſt c
things neceſſary, you may frame a Table o
gles at the Pole, as was directed in the Ch
in upright decliners; and from thence you
find alſo the Hour *Arches*, and ſet them
in a Table as you ſee here followeth.

	Angles at the Pole		*Hour Arches*		
H. Eaſt	*d.*	*m.*	*d.*	*m.*	*H. Eaſt.*
5	85	26	74	11	7
6	70	26	38	26	6
7	55	26	22	16	5
8	40	26	13	31	4
9	25	26	07	38	3
10	10	26	02	58	2
Subſtile					*Subſtile.*
11	04	34	01	17	1
12	19	34	05	44	12
1	34	34	11	00	11
2	49	34	19	07	10
3	64	34	31	40	9
4	79	34	56	53	8

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The Canon for Calculation is,

As the Radius.	90	00.	100000
Is to the fine of the Reclination.	20	00	95340
So is the *Tang*. of the old Decl.	20	00	95610
To the *Co-Tan.* of the dif. of the *M.* & *H.*	82	54	90951

Having found the Quantity, the *Meridia* makes with the Horizontal-line; the next thin is to find to what Coast it must run, and either a bove it or below it.

Now in all South Planes that doth recline an decline so much that the Plane becomes less tha an *Equinoctial* Plane, the *Meridian* doth defen below the Horizontal line at that end which li contrary to the Coast of the Declination. And i all *North* Planes Inclining and Declining, so muc as to make it less than an *Equinoctial* Plane, th *Meridian* will ascend above the *Horizontal* line a that end which lies contrary to the Coast of th Planes *Declination*.

Having shewed you to what Coast the *Meridia* must run; we now come to the drawing of th Dial, Geometricaly.

The Geometrically Projection.

Draw the line W C E, for the *Horizontal* lin of the *Plane*, then in the point C, with 60. de of Chords describe the Circle W M E, and fro W, to M, (because the Plane *Declines East*) s 82. 54, the distance of the *Meridian* and *Horizo* and draw the line C M, for the Hour-line 12.

Then take 05. 43. the Substiles distance, *set from M*, to O, and 16. 23, and set fr

to P, and draw CO, for the *Substile*, and CP, for the *Stile*.

Lastly, Take 01. 17, 05. 44, 11. 00, 19. 07, 30. 40, and 56. 53, and set from O towards E, Likewise take 02. 58, 07. 38, 13. 31, 22. 16, 38. 26, and 74. 11, and set from O, towards W, and from C, the Center draw lines to every one of the Points, they will be belonging to the Plane.

How to draw this Dial by the Line of Latitudes, and Hour Scale; the Requisites being Calculated.

Having drawn your Horizontal, and set off the distance of the *Meridian* from the *Horizon*, the Substiles distance from the Hour line of 12 or *Meridian*, and the Stiles height, draw a Line as B D, passing thro, the Center C, and *Perpendicular* to the *Substile*.

Then out of your Scale of *Latitudes*, in page 62 take 16, 23, and set from C to B, and D, then take in your Compasses, the length of the whole Scale of 6 *Hours*, and set one foot in B, and turn the other foot till it touch the *Substile*, as at A, and draw a line A B, and A D.

The Inclination of *Meridians* in this Example, was found to be 19. 34, seek that on the second Scale of 90 deg. and just against it on the first Scale you shall find 1 hour 19 min. which shews that the *Substile* stands upon 19 min. past 1, on the *Dial* declining *West*, and 41 min. past 10 on the *Dial* declining *East*.

Now repair to your Table of *Angles* at the Pole and take 04. 34, from your Scale of Inclination

Meridi

ıd ſet from A, to *XI*, and from B, to V, then
. 34, and ſet from A, to XII, and from B,
:hen take 34. 34, and ſet from A to 1, and
ı, to VII. then take 49 34 and ſet from *A*,
and from B, to
hen take 64. 34.
from *A*, to *III.*
om B, to IX.
ıke 79. 34, and
n A, to IV, and
ı, to *X. Laſtly*,
lrawn from the
C, thro' every
:heſe points ſhall
Hour-lines for
Dial.

Eaſt.	*A.*	*P.*	*Weſt.*
11	04	34	1
12	19	34	12
1	34	34	11
2	49	34	10
3	64	34	9
4	79	34	8

ı *find what time the Sun forſaketh the North*
ning Plane to ſhine upon this South reclining
e.—The Sun being in Cancer.

Radius	90 00	10,00000
e *Co-Tan.* of the *Suns Decl.*	66 30	9,68865
e *Tang.* of the Stiles height.	15 45	9,45029
Co-ſine, of	82 57	9,08894
which Subt. *Planes Long.*	19 34	
will remain	63 23	

converted into time, by allowing 15 deg.
ry Hour, and a deg. to 4 min. gives 4 *Hours*
. after Noon, when the Sun parteth from the
'eclining and reclining 20 deg. 00 min. Ea
ınd ſhineth upon the North Inclining W

the part opposite thereto: To find the time in the Morning, when the *Sun* forsaketh the *North* Inclining *West*, to shine upon the *South* declining *East*.

Unto the Co-sine before found *viz.*	82,57
Add the planes Longitude,	19,34
The Sum is,	101 : 91

Which is 202. 31, that be resolved into time giveth 6 hours 50 min. from Noon, that the Sun leaveth the *North* Inclining Plane, to shine on the *South* Recliner: Or if you take the Complement of 102. 31, to 180 deg. which is 77. 29, it giveth 5 hours 10 min. the time from Noon.

CHAP. XIII.

HAving the Declination given, to know what Reclination will make it an *Equinoctial* Dial, Or having the Reclination given, to know what Declination it requires to make it also an *Equinoctial* declining *Dial*.

Whereby you may know at any time if your reclination and declination: or declination and reclination makes your Dial plane more, or less, than an *Equinoctial* declining Dial.

Let the Declination given be 65 deg. 40 min.

the Radius	90	00	10,00000
to the Co-Tang. of the Lat.	51	30	9,90060
is the Co-sine of the Decli.	65	40	9,61494
) the *Tang*. of the *Reclination*	18	09	19,51554

.et the Reclination given be as found 18 09.

; the Radius	90	00	10,00000
to the *Tang*, of the Latitude	51	30	10,39939
) is the *Tang*. of the Reclinat.	18	09	9,51563
o the Co-sine of the Declina.	65	40	19,61502

CHAP. XIV. *Fig.* 23.

ow to draw the Hour-lines *upon any* Declining *Equinoctial Plane.*

et the Example be of a South Plane, *Declining* East 65 *deg.* 40 *min. and* Reclining 18 *deg.* 9 *min. in the* Latitude *of* London 51 *deg.* 30 *min.*

N *Declining Reclining Equinoctial Dials*, before the Hour-lines can be drawn, Three hings must be given, and two Things found; ie Things given are,

1. The Latitude of the Place, 51 30
2. The Declination of the Plane, 65 40
3. *The Planes* Reclination, 18

The Things found are,

1. The Diſtance of the *Meridian* and *Hori*
2. The Inclination of the *Meridians.*

For the Diſtance of the *Horizon* and *Me*
an, Thus,

As the Radius, or ſine of 90 deg. 10,000
Is to the ſine of the Reclination, 18 9—9,493
So is the *Tang.* of the Declinat. 65 40 10,344
To the *Tangent* of 34 deg. 34 min. — 19,838

Whoſe Complement 55 deg. 26 min. is
Diſtance of the Meridian and Subſtile from
Horizontal-line.

For the Inclination of the *Meridian* of the P
from the Meridian of the Plane, Thus,

As the Radius, or ſine of 90 deg. 10,000
Is to the ſine of the Latitude 51 30—9,893
So is the *Tang.* of the Declina. 65 40 10,344
To the *Tang.* 59 deg. 55 min. ——— 10,237

Now becauſe 59 deg. 55 min. is almoſt 4 h
diſtance from the Meridian, I conclude that
Subſtile ſhall fall near 8 of the Clock, on the
ſide of the Meridian: Becauſe the Plane dec
eth *Eaſt.*

The Requiſites being found, Draw the *Hori*
tal-line DA, then with the Radius of your L
of Chords, deſcribe the Arch A B, and ſet the

om A to B 55 deg. 26 min. the distance of the Meridian or Substile from the Horizon, and draw D for the Substile. Then perpendicular to the *Substile*, draw the Lines F G and C E, having found the Inclination of Meridians to be 59 deg. 5 min. find it on the *second* Scale, and against it in the first *Scale* you shall find 3 Hours 59 min. Then having Recourse to the Table following, set off the Hours from K to H, according to the Directions of the 27th Chapter, for the far declinar, taking the several Distances with your Com-

From K *towards* E.			*From* K *towards* C.		
D. M.	H.	on the Plane.	H. M.	H.	on the Plane.
59	K	9	0 1	K	8
59	K	10	1 1	K	7
59	K	11	2 1	K	6
59	K	12	3 1	K	5
59	K	1	4 1	K	4

passes out of either of the Polar Scales, and setting them off from K towards C and E, as the Table plainly sheweth, drawing Lines parallel to the *Substile* through those Points, and those lines shall be the Hour-lines required for that Plane. The extent of the Compasses from the beginning of the same Polar Scale to the Hour of 3, gives the height of the Stile above the Substile, which may be a Plate of *Iron* or *Brass* set up just over the *Substile* H K; and so the Dial is finished.

SEC

SECT. I.

How to find what Time the Sun *passeth from one side of an* Equinoctial Plane *to the other.*

EVERY *Plane* Reclining to the Equinoctial is coincident, with some Hour-Circle, or parallel, and therefore the Sun, in what parallel passeth from one side of that *Plane* to the other, at the same Hour and Min. which you may see by the following Canon.

As the sine of the Latitude	51	30	9,89354
Is to the Radius	90	00	10,00000
So is the *Co-Tan.* of the *Plan.* decl.	65	40	9,65534
To the Tangent of	30	00	9,76180

Which 30:00 being converted into Time, giveth 2 Hours from Midnight, when the *Sun* passeth from the Inclining to the Reclining *Plane*, and reckoned from Noon, when the *Sun* forsaketh the reclining *Plane*, and shineth upon the Inclining side again. And thus it continues till the *Northern* Amplitude or the Sun is equal to 65:40 the Declination of the *Plane*, from thenceforth it shines no more upon the Inclining Part in the Morning, and when the *Southern* Amplitude of the *Sun* is equal to 65:49, the Declination of the *Plane*, then it forsaketh the inclining side at Evening also, and the rest of the Year it only Inlightneth the reclining side of the Plane.

Note, The *Meridian* in all these Planes run *North* and *South*.

CHA

How to draw Hour-lines *upon a* South *Reclining* Dial, *declining* East *or* West, *which passeth between the* Pole *and the* Horizon.

THE third Variety in *South* decilning reclining Dials, is of those that pass between the Pole of the World and the Horizon; therefore because the Plane falleth between the *North* Pole and the Horizon, therefore the *North* Pole is elevated above it; from whence you may conclude that the Center of the Dial must be downwards upon the Plane, and the Hour-lines running upward to the *North* Pole.

Example, Let the Latitude of the Place be 51 30
The Declination of the Plane be 33 00
The Reclination of the Plane be 55 00

I. To find the Latitude of the Place wherein this Plane stands as an upright Decliner.

As the Radius	90 00	10,00000
Is to the Co-sine of the old Dec.	30 00	9,93753
So is the Co-Tan. of the Decli.	55 00	9,84522
To the Tangent of	31 14	19,78275

The Difference between this Tangent and the Latitude 51 30, is 20 16, whose Complement 69 44, is the New Latitude.

II. The referring of this Plane to a New Latitude, doth alter the Declination; therefore a new *Declination* must be found.

As the Radius,	90	00	10,
Is to the Co-sine of the reclina.	55	00	9,
So is the sine of the old Decl.	30	00	9,
To the sine of the new Decl.	16	40	19,

Having found the new Latitude and ne clination, you may find the *Substiles* distance the *Meridian*, the *Stiles* height, and the I difference of Longitude, as you were di for upright Decliners.—Only *Note*, Instead sing the Old Latitude and Declination, you use the new Latitude and Declination.

The distance of the Meridian and Horizor be found by the Directions of the 12th Ch: Page 98.

Old Latitude,	51	30
Old Declination.	30	00
Reclination of the Plane.	55	00
New Latitude.	69	44
New Declination.	16	40
Substiles Distance from	06	03
Stiles Height.	19	25
Planes Longitude.	17	42
Meridians Distance from the Horizon.	64	41

Hours from the Substile.	Equinoctial Distances.		Hour Arches.		Hours from the Substile.
East Dial.	D.	M.	D.	M.	West-Dial.
5	87	22	82	07	7
6	72	22	46	17	6
7	57	22	27	26	5
8	42	22	16	52	4
9	27	22	09	46	3
10	12	22	04	10	2
Substile.					Substile.
11	02	38	00	53	1
12	17	38	06	02	12
1	32	38	12	01	11
2	47	38	20	01	10
3	62	38	32	42	9
4	77	38	56	35	8

Having the Requi you may fr Table of A at the Pole cording t Direction c right Decl From thenc may find Hour Arc and set down as see in this ble.

1. Draw the Horizontal-line A B, then on G e Center, with 60 deg. of Chords, describe the ircle AEB, then take 64:41, the distance of the *leridian* and *Horizon*, and set from B to C, be-nse the Plane declines Eastward, and draw the ine G C, for the *Meridian* or 12 a Clock; then ke 06:03, the Substiles distance from the *Me-lian* and set from C to D, on the Right-hand of e *Meridian*, because the Plane declines East-ards, also take 19:25, the Stiles height and set om D to E, and draw G E, for the Substile, and E, for the Stile.

Then from the same Line of Chords you de-ribed your Circle AEB, take 82:07, 46:17, 27-5, 16:52, 09:46, 04:10, and set from the *Substile* , for the Hours of 5, 6, 7, 8, 9, and 10 in the orenoon: Then take 00:53, 06:02, 12:01, 20 5, 32:42, 56:25, and set from D, the Substile, r 11, and 12 at Noon, and 1, 2, 3, 4, in the fternoon, and from C, the Center of your *Dial* aw Lines thro' the several Points, you have the our-lines desired.

Lastly, Let the Stile make an Angle of 19:25, ove the Plane, and be set perpendicular to the ubstiler-line G F, and raise the Plane to make a Angle of 35 deg. above the *Horizon*, and de-ining *East*, 30 deg. it will shew the true Time f the Day: Wherein note, That having made his one Dial (or any of the like) you have at once ade four, changing but the Position of the Dial, *nd altering* the number of the Hours, as th *me doth* require, For first, this answereth

the opposite *North* declining 38 deg. *West*, and Inclining to the *Horizon*, 55 deg. also the *South* declining *West*, 30 deg. and reclining 55 deg. and to his opposite *North* declining *East* 30 deg. and reclining 55 deg.

And *note*, In all *South* Recliner more than an *Equinoctial* the Meridian doth ascend above the *Horizontal-line*, at the end which lies the same way with the Planes Declination.

And in all *North* Inclining Declining Planes more than the *Equinoctial*, the *Meridian* doth descend below the *Horizontal-line*, at that end which lies the same way with the Planes Declination.

Those *South* Planes are *Equinoctial* Decliners, whose Reclination, and Declination maketh them fall into the *Pole* of the World, that is, the *Plane* doth pass thro' both Polar, and by that reason the Stile doth make no Angle with the *Plane*, but doth lie parallel to it, and those Planes, are said to be less than Equinoctial Planes that pass between the *Zenith* and the *Pole*, and those more than *Equinoctial Planes* that pass between the *Pole* and the *Horizon*.

Note, That in the Operation (in *South* Planes) in finding the New Latitude, if that the *Tangent* that comes out be equal to the Latitude of the Place, that *Plane is said* to be an *Equinoctial-Plane*; but if more than the Latitude, it is less than an *Equinoctial-Plane*, but if less than the Latitude, then is it more than an *Equinoctial Plane*.

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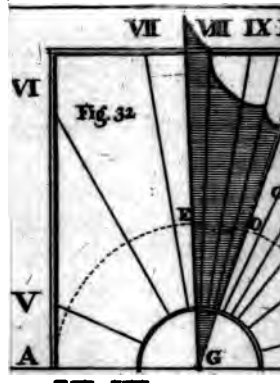

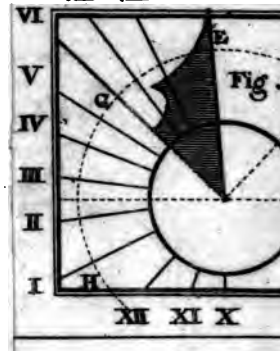

Latitude *of the place, the* Sun's *Declination* *ith the Declination, and reclination given, to* *nd what time the* Sun *forsaketh the* South *re-* *ining Plane, to shine upon the* North *reclin-* *g opposite thereto.*

S the Radius 90 00 10,00000
Is to the *Tan.* of the *S. decl.* 23 30 9,63830
s the Tan. of the *Stiles* heig. 19 25 9,54713
:he Co-sine of 81 11 19,18543
nto this Co-sine 81 11. add the *Planes* Lon-
de 17 42, the whole Angle is 98 53—90
is 6 hours, therefore 08. 53. resolved into
giveth no Hours, but 35 min. before 6 at
ıt, when the Sun in *Cancer* forsaketh the
reclining, to Shine upon the Inclining side
:of, or again the Co-sine 81. 11. resolved in-
me giveth 5 Hours 25 min. from Noon, that
ɔun in the Morning, parteth with the North
ning *Plane*, to Shine on the South reclining
, opposite thereto. Thus I have done with
h reclining *Dials.*

Of North Recliners.

CHAP. XVI. Fig. 23

to draw Hour-lines, *upon a North Reclining* *clining* Dial 60 *deg. Westward and Reclining* *deg. from the Zenith toward the* Equinoctial.

1. *To find the* New Latitude.

AS the *Tan.* of the Planes reclination
C. *Arithmetical* —— 0,5
Is to the *Radius* — 90 00 10,0
So is the Co-sine of the Planes decl. 60.00.9,6
To the Co-Tangent of —— 29 50 19,2

This *Co-Tang.* being compared with the Lat
51. 30, there difference 21.40, is the new *La*

2. To find the New *Declination.*

As the *Radius* —— 90 00 10,0
Is to the Sine of the Declination, 60 00 9,9
So is the Co-sine of the Reclina. 16 00 9,9
To the sine of the New declina. 56 40 19,9

3. To find the distance of the *Mer.* and *H*

As the Radius — — 90 00 10,0
Is to the Sine of the *Reclinat.* 16 00 9,4
So is the Tangent of the old decl. 60 00 10,
To the *Co-Tan.* of the dist. of the Meridian and Horizon, } 64 29 19,

The Latitude of the Place ——
The Reclination of the Plane
The decl. of the Plane from the *NorthWest.*
The New Latitude — ——
The New Declination in that Latitude,
The distance of the Mer. and Horizon,
The distance of the Substile from the Mer.
The Stiles height above the Plane,
The Planes difference of Longitude

Having found these things, as you were

ly, you may proceed to the making of a of *Equinoctial* Diſtances, and ſo calculate ie Hour Diſtances, as you were Taught in t Decliners, and they will be as followeth.

The *Geometrical* Projection,

w an Hori- line almoſt Middle of ne, as AC, n choſe a n the *Hori- ine* for a *Cen-* at C, and o deg. of make the ABG, from t Point of *izontal-line,* elp of a line rds, ſet A, 9, the di- of the *Me-* nd *Horizon,* *North* part *Meridian,* or perly from

Weſt Decliner.	*Equinoctial Diſtances.*		*True Hours diſtance.*		*Eaſt Decliner.*
Hours.	*D.*	*M.*	*D.*	*M.*	*Hours.*
1	88	50	87	44	11
2	73	50	60	37	10
3	58	50	40	24	9
4	43	50	26	18	8
5	28	50	15	49	7
6	13	50	7	13	6
Subſtile.					*Subſtile.*
7	1	10	0	36	5
8	16	10	8	29	4
9	31	10	17	18	3
10	46	10	28	12	2
11	61	10	43	5	1
12	76	10	64	26	12

Weſt point of the Horizontal-line upwards ne *South* part thereof, and draw the Line , for the 12 a Clock Hour-line; from D t 64:21, the diſtance between the Sub- l the *Meridian* Eaſtwards from it, and e pricked line C E for the Subſtile, fro

the point *E*, in the Substile, by help of a Lin of Chord, set off the True Hour distances bo ways in the Circle towards *G*, and *D*, as you find them in your Table; unto every prick draw streight Lines from *C*, to the Centre, so shall you have all the hour-lines proper for this Dial.

Lastly, from *E*, to *F*, set off the height of the stile 30:59, and draw the Line *C*, *F*, representing the *Axis*, which being erected at right *Angles* over the *Substile C*, *E*, and must point upwards to ward the *North* Pole, so is the *Dial* fit for Use and must be placed according to the *Declinatio* and *Reclination* of the *Dial*.

Note, In Declining Reclining less than a Polar the Meridian ascends above the Horizontal Line the same way with the Coast of Declination, an represents 12 a Clock at Night; and in the *South* Declining Inclining Dial less than a Polar, th *Meridian* doth ascend below the *Horizontal* Lin the same way with the *Declination*.

SECT. I.

How by having the Lat. *of the Place, the* Sun *Declination, the Declination and Reclination given, to find what Line the* Sun *parteth from t* South *Incliner, to Shine upon the* North *Rec zer, opposite thereto.*

As the *Radius*	90		10,000
Is to the *Tan.* of the *Sun*'s decl.	23	30	9,638
So is the Tan. of the Stiles heig.	30	59	9,778
To the Co-Sine of	74	52	19,4

Out of the *Planes* Long. 76: 10, take 74: 52, here will remain 1 deg. 18 min. which converted into Time, giveth only 5 min. before Noon, when the *Sun* forsaketh the Inclining side of the *Plane*.

CHAP. XVII. Fig. 34.

How to draw Hour Lines *upon a* Polar Dial, *Declining* East *or* West 60 *deg. and Reclining* 32:11.

BEfore I shall shew how *Hour Lines* are to be described on these *Dials*, I shall shew, how having a *Declination* given, to find a *Reclination* that will make it a *Polar Declining Dial*: Or having the *Reclination* given, to find what *Declination* will do the like.

The Canon for Calculation.

As the Co-Tan. of the Lat. Com. Arit.	51	30	0,09939
Is to the *Radius* —— —	90	00	10,00000
So is the Co. Sine of the *Planes De.*	60	00	9,69897
To the Tan. of the *Reclination*.	32	09	9,79836
Again,			
As the *Radius* —— —— —	90	00	10,00000
Is to the *Tan.* of the Reclination.	32	09	9,79830
So is the Co-Tan. of the Latitude	51	30	9,90060
So is the Co-sine of the *De.* requ.	60	00	9,69890

In these sort of *Planes* you have only the height of the *Stile* above the *Substile*, and the distan

of the *Meridian* to find; now forasmuch as the distance of the *Substile* from the Meridian is 90: 00, and by that reason the *Plane* is an upright *Plane* where there is no *Latitude*, therefore the distance of the *Equator*, from the *Pole* being 90: 00, also; therefore the *New Declination* will be equal to the height of the *Stile*, which you may find by the following *Canons*.

As to the *Radius*.	90	00	0,00000
Is to the *Sine* of the *Planes* Decl.	60	00	9,93753
So is the Co-sine of the *Reclin*.	32	09	9,92770
To the Co-sine of the *Planes new De*.	42	52	19,86520

Which is the Height of the *Stile* above the *Substile*; also you may find the distance of the *Meridian* and *Horizon* by this *Canon*.

As the *Co-Ta*. of the *Planes De*. C. A.	60	00	0,23856
Is to the *Radius*	90	00	10,00000
So is the *Sine* of the *Planes Recli*.	32	09	9,72602
To the *Co-Tangent* of	47	20	9,96458

The *Latitude* of the *Place*	51	30
The *Declination* of the *Plane*	60	00
The *Reclination* of the *Plane*	32	09
The *New Latitude*	00	00
The *New Declination* in that *Lat*.	42	52
The *Distance* of the *Substile* from the *Mer*.	90	00
The *Height* of the *Stile* above the *Plane*	42	52
The Planes Difference of the Longitude	90	00
The Dist. of the *Meridian* and Horizon	47	20

Hence you may see the Planes Difference

ıde, being 90 deg. the *Substile* must be the
ock Hour-line, and the Hour Angles on
side of the Hour of Six is equal, therefore
ıt the adding of 15 deg. on either side the
, and you have a Table of *Equinoctial* Di-
, and from thence you may calculate the
Hour, as you where taught in *Upright De-*
The *Table* followeth.

The *Geometrical* Projection.

Hours from the Subst.	Equinoctial distance.		True Hours distance.		Hours from the Substile.
Hours	D.	M.	D.	M.	Hours
6	Substile		Substile		6
5	15		10	20	7
4	30		21	27	8
3	45		34	14	9
2	60		49	41	10
1	75		68	30	11
12	90		90	00	12

e *Table* prepa- raw the ontal- 1, *C*, *B*, ne mid- f the and *Pa-* o the n, in a- t there- at the C, with

g. of Chords draw the Circle *H*, *G*, *E*, *F*, t 47:20, the distance of the *Meridian* and *n*, from *B*, the *West* End of the *Horizontal* o *F*, upwards, and draw the Line *F*, *C*, *D*, e Hour of 12, then set 90 deg. the *Sub-* istance from the *Meridian*, from *F*, to *G*, raw *C*, *G*, for the *Substile* and Hour-line set off from G, each way, by help of a f Chords upon the Circle E, G, H, th istance, as you find them in the T

viz. for the *Hour* of 5, and 7, 10 deg. 20 min. for 4, and 8, 21 deg. 27 min. and so of the rest (but past 8 you need add no more,) so shall you have *Points* unto which streight lines being drawn from the *Center*, are the true *Hour-lines* on the *Plane*.

Lastly, From G, either way set off the height of the *Stile* 42 deg. 52 min. from *G*, to *E*, and draw the *line C, E*, for the *Axis* of the World, which being erected perpendicular over the *Substile*, the *Dial* is finished; but observe that your *Dial* be set to its true *Declination* and *Reclination* proper to the same.

☞ *Note*, The *Meridian* in all *North Declining Polar Dials*, descend below the *Horizontal-line*, at that End which is contrary to the Coast of the Declination: And the *Meridian* in all *South Declining Polar Dials*, doth descend also from the contrary Coast of Declination, and the six a Clock hour-line is always the *Substile* in both.

SECT. I.

The Latitude of the Place, the Declination *of the* Sun, *together with the* Reclination *and* Declination *given to find what Time the* Sun *forsaketh the* South *Inclining side, to shine upon the* North *Declining side, opposite thereto.*

As the Radius,	90	00	10,00000
Is to the Tan. of the *Sun's* Decl.	23	30	9,63830
So is the Tan. of the *Stiles* heig.	42	52	9,96760
To this Co-sine,	66	12	9,605[illegible]

Out of the *Planes* Longitude 90 deg. take 66.12, there will remain 23.48, which converted into time, giveth one hour 35 min. before Noon, when the *Sun* leaveth shining on the Inclining, and shineth upon the Reclining side.

CHAP. XVIII. Fig. 35.

How to draw the Hour-Lines upon a North *Dial declining* 60 *deg.* West, *and reclining* 54 *deg. which cutteth the Meridian between the Equinoctial and the Horizon.*

THE making of this *Dial* differeth little from the former, therefore find the Requisites as you did in the former, that is first the New Latitude and New Declination find the distance of the Meridian and Horizon, and the Substiles distance from the Meridian, the Stiles height above the Plane, the Planes Longitude; and Hours distances as you have been taught in the former Chapters.

I shall not trouble you with Calculating the Requisites from this Plane; because they may be found by the last Chapter but one, and therefore it is needless to say any more about them, but they are Calculated, and are as followeth.

The Latitude of the Place	51 50
The Declination of the Planes *West* —	60 00
The Reclination of the Plane — —	54 00
The Plane's *new* Latitude — — —	18 30
The Plane's new Declination — —	30

The distance of Meridian and Horizon
The Sub. distance from the Mer. 123. 09.
The Stiles height
The Plane's Longitude 118 13, or

Having the Plane's difference of Lo
you may frame a *Table* of Equinoctial d
and find the Hour distances, and place th
this *Table* following.

The *Geometrical* Projection.

Hours.	*Equinoctial distance.*		*True Hour distance.*		*Hours.*
	D.	*M.*	*D.*	*M.*	
12	61	48	56	41	12
11	46	48	40	49	1
10	31	48	26	50	2
9	16	48	13	50	3
8	1	48	1	97	4
Substile.					*Substile.*
7	13	12	10	51	5
6	28	12	23	39	6
5	43	12	37	29	7
4	58	12	52	48	8
3	73	12	69	43	9

Draw t
zontal Lin
A, about t
dle of the
Parallel to
tom, then
a *Centre* v
deg. of Ch
scribe the
F, *D*, *G*, a
the *East* p
the *Horiz*
B, to *G*, se
the Distanc
Meridian a
rizon, an
the Line (
the Twelve a Clock hour-Line, then se
41. the Substiles distance from the Meridi
G, to *D*, and draw the Line *C*, *D*, for
stile, and set off 54.46 from *D*, to *F*, for t
so shall D, *F*, be the Stiles height above th

en set the *Hour* distances from the *Substile* both
ays, as you find them in the *Table* (as you have
en taught in the foregoing Chapters) and thro'
e Points draw Lines, and set the Stile right o-
r the Substile, and then you have finished four
veral Dials. This for one, and his Opposite
clining 54 deg. to the *Horizon*, and Declining
st 60 deg. and his opposite *South* Inclining 54
g. and Declining 60 deg. *West*, only turning the
ials upside down, and changing the Figures of
e *Hours* for Forenoon and Afternoon, as the
ials will direct you; and so may be done to all
ials whatsoever, except the direct *East*, or *West*,
r there can be but two, for the back-side of the
st, is the *West*.

Note, The Meridian in all *North* Recliners
ore than at Polar (as this is one) doth ascend
low the *Horizontal-line*, and from that End
hich lies contrary to the Coast of the Plane's
eclination, and in the *South* Inclining and De-
ning more than a Polar, the Meridian doth
cend above the *Horizontal-line*, contrary to the
oast of the Declination, and is only serviceable
e to draw the Dial.

Note also, In the *North* Reclining Declining
ials, if that Tangent that comes out in finding
e new Latitude be equal to the Complement of
e Latitude of the Place, then is that a Polar
ane, if the Complement of the Latitude exceed
e Tangent, then is the Plane less than a Polar,
t if the Tangent found, doth exceed the Com-
ement of the Latitude, then is the Plane more
n a *Polar-Dial*.

SEC

SECT. I.

Having the Latitude of the Place, the Sun's *Declination, with the Declination, and Reclination of the* Plane, *given to find what Time the* Sun *forsaketh the* South *Inclining side to shine on the* North *Reclining side Opposite.*

As the Radius,	90	00	10,00000
Is to the *Tan.* of the *Sun's Decl.*	23	30	9,63839
So is the *Tan.* of the Stiles heig.	54	43	10,15021
To this Co-sine of	52	05	19,78851

Unto the Angle 52:25, add the *Plane's Longitude* 61:47, from the *North*, or out of the Angle 118:13, counted from the *South*, there remains 66:08, which converted into Time, giveth 4 Hours, 14 Min. before Noon, when the Sun forsaketh the Inclining side of the Plane, and shineth upon the Reclining side thereof.

CHAP. XXI. *Fig.* 12, & 13,

Directions for making Two Sorts of SPOT-DIALS, *very useful to shew the* Hour *within the House.*

A Description of the Spot-Dial.

THE *Spot-Dial*, is of two sorts; in the one a *bright* Spot goes to the Lines, in the other *the Lines* go to a black Spot; the former being ex-

plain

ined, the latter cannot be unknown. The
nner of drawing the Hour-lines, is the ſame
is ſhewed on any other Dials, in the foregoing
apters; but conſider, if there was an Axis or
le on this Dial, it would paſs through the Back-
ard (which all ſuch Dials muſt have) and the
ry Point where the Axis doth go through, is the
ace where a hole in the one, and a ſpot in the
her is to be made, that at any time (the *Sun*
ining) will ſhew you the Hour of the Day.

SECT. I.

For the making of theſe Dials.

. Get the Joyner to make you a moulded wood-
Frame, with miter-joynts, like the frame of a
oking-Glaſs, or ſuch a Gilt Frame, as are made
r Pictures; about 8 Inches long, 5 Inches broad,
d an Inch and half thick, and nail upon one of
e longeſt edges of the Frame a piece of thin
oard a little longer than the Frame, and but half
broad: This piece of Board is for the bottom,
d be ſure that your Frame ſtands exactly per-
ndicular upon the bottom piece: Then for the
ck of your Frame, get a thin plate of Wood,
actly fit for it, and at the top of this Plate of
ood make a hole about 3 Inches long, and two
ches broad, and upon that nail a piece of Tin,
rather Copper-Plate.

2. *You* muſt get a piece of Crown Glaſs fit for
ur Frame, and grinde one ſide of it till it is
id as Paper, thus: Lay your Glaſs upon a

nen, or Woolen Cloth to keep it from breaking; then with a ſmall piece of Glaſs, and *Calice-Sand* grinde your Glaſs, but you muſt have a great care not to grinde the other ſide; for in little time you may ſo ſmutch the Glaſs by heedleſs miſtake of the ſide, as to make it uſeleſs.

3. Having found the Declination of your *Glaſs-Window*, againſt which it is to ſtand, make a Dial exactly the bigneſs of your Glaſs upon Paper, to that Declination, with *Stile* and *Subſtile* drawn upon the Paper, as if you were to make it for the Wall without Doors, or outſide of the *Window*: but the Figures of this *Paper-Dial* muſt be inverted, or made backward as in Figure 13; and if you Write in *Roman Letters*, for Nine you muſt Write Eleven; and therefore your beſt way is to have a Copy before you, of Figures ſo drawn.

4. Now to find where the Spot will be; remember that it will be always in the *Subſtile*, and as far diſtant from the *Stile*, as is the diſtance between your Glaſs and the Tin: Put therefore your Glaſs already ground, into the Frame, and take the neareſt diſtance between your Glaſs and Tin; for this end make a ſquare of Paper; and applying one ſide to the Glaſs as it lies in the Frame, make a point at the neareſt diſtance, and clip off the reſt of the Paper at that point; with that diſtance come to your Dial on the Paper, and lay the longeſt edge of this ſquare to the *Subſtile*, and carry it backward or forward upon the *Subſtile*, till the marked point juſt toucheth the *Stile*; then holding it, draw a line from the Subſtile to the *Stile*, and mark that point upon the Paper-Dial, where this Line cutteth the *Subſtile*, viz. at the corner of

Square (which I call the *Substile point*) and
w a round ☼ about it, that you may know
gain.

. Having drawn your *Paper-Dial* the exact
nesſ of your Glaſs, and found your Subſtile-
nt, you muſt draw the Hour-lines upon the
gh ſide of the Glaſs, thus: Wet the Figured
of your *Paper-Dial* with Gum-Water, and
it on the ſmooth ſide of your Glaſs; and when
dry, ſet one Foot of your Compaſſes upon
Center of the *Dial*, and open the other to the
ſtile-point; with that diſtance deſcribe a *Semi-*
le, and from that *Semicircle* draw all your
ur-line with a Pen and Ink, by the ſide of a
ler upon the rough ſide of the Glaſs; your
ures muſt be drawn wrong as they appear
ough the Glaſs, which you will find to be right
en your Dial is in the Frame, and finiſh'd.

, Mark your Subſtile-point upon your Glaſs,
take off your Paper-Dial.

. Make faſt your Glaſs in the Frame with
ll Tacks, the rough ſide next the *Back-board.*

. Make a little hole in the Tin, perpendicular
r againſt the Subſtile-point, which you will
by the Paper-ſquare; by which you may draw
erpendicular line from the Subſtile-point, and
it upon the Top of the Frame, and ſo draw
own your *Back-board*; then take the diſtance
n the *Subſtile-point* to the outermoſt Edge, or
of the Frame, and ſet it upon your line drawn
your *Back-board*, from the Top downwards,
ich diſtance will be perpendicular over your
ſile-point.

And *laſtly*, With *White-lead* and Linſe

Oyl ground together, Paint the rough side *Glass*; then glue on your *Back-board*, and *Dial* is finished.

Now your *Dial* being made, set it close to *Glass-Window*, and the *Sun* entring thro' the hole, will cast its Ray upon the opposite *lines*; and so give the time of the Day.

I need not say much of that Form, wh the Lines go to the *Spot*, for it is but the inverted, as if you should turn this upside d and draw the Lines towards *Window* or upon a clear *Transparent Glass*, and on the toward the *House*, instead of the Plate of and the Tin, you must have a *Glass* ground, one black *Spot* at the bottom, where the h in the Tin, unto which Spot every Line will successively, according to the time of the Day the Figures must be made upon the clear G Top; and there must be a great square Q of Glass in the *Window* behind it, for the will make a very unhandsome Confusion.

SECT. II.

How to draw Hour-lines *upon the* Window-b Walls, *and* Floor *of a* Room, *the* Sun *s through a small* Hole *made in any* Pane *or* Q *of* Glass *in the* Window.

FIrst, if in the *Glass-Window* of any *Room Pane* or *Quarry* of Glass be darkned, a *Hole* made about half a quarter of an Inch di *n the middle thereof*, the Sun shining ov

indow, will through that hole cast a bright *Spot Light* into the *Room*, which as the *Sun* in his otion passeth by the *Window*, the *Spot* of *Light* ill be also removed from place to place, somenes upon the *Window-board*, sometimes upon e *Jambs*, sometimes upon the *Sides* and somenes upon the *Floor* of the *Room*: If such a *Hole* ould be supposed to be the *Nodus* or *Point* of e *Top* of the perpendicular *Stile* of any *Dial*, I y from it the *Hour-lines* of a *Sun-Dial*, or of veral *Dials* (for every side or part of the *Room* a different *Plane*) may be made about the *Room*

1. *Horizontally* you apply an Horizontal-Dial the Hole in the *Glass-Window*, and extend a read Horizontally also from that Hole, over ery Hour-line (or half and quarter Hour-line) l it touch the *Sides*, *Doors*, *Windows*, *Jambs*, or her *Objects* or *Impediments* (standing in the way) out the *Room*: Then,

2. The *Twelve* a Clock Hour-line, being both *Hour-line*, and an *Azimuth* also; you may (by perpendicular Thread, or Threads,) transfer the me to the *Cieling* or *Floor* of your *Room*, or to hich of them will best serve your Turn, and metimes there may be occasion for both: Then,

3. In this *Meridian line* find any *Point*, from hich a Line or Thread extended to the Hole in e *Window*, may represent either the Direct (or everted) Axis of the *World*, and unto that *Point* r *Points*; all the Hour-lines which you draw in at *Room* will have respect unto, (or be in the me *Plane* with) this *Axis*: and therefore,

4. *If you fix a* Thread in one or both of th

Points, (or *Poles* rather) and extend that *St*
by the side of another *String*, extended from
Hole over any *Hour-line* or *Point*, found on
side of the *Room* (as before) that moveable *St*
being gently moved by the side of the *Horize*
String, shall trace out (upon all *Objects* tha
meets withal) the *Hour-line*, which the exten
Horizontal String doth represent.

CONCAVE DIALLING

CHAP. XXII.

How to draw Hour-lines in the Inside of Rec
Concave Hemispheres.

THese *Regular Concave Hemispheres* are
most natural *Planes*, upon which *H*
lines may be described, for they do naturally
present the *Sphere*; and the manner how the *H*
lines and *Furniture* may be described, into s
Dials, shall be the Work of this and the n
Chapter.

SECT. I Fig.

To make a Horizontal Concave Dial.

HAving a *Concave Hemisphere* prepared:
S. N. E. W. divide the Limb into 4 Q
drants, noted as the former Letters; one of
Quadrants divided into 90 deg. open your C

asses to the Quadrant, and setting one Foot upon E. or W. with the other, draw the *Meridian* or 12 a Clock *Hour-line* SZN take out of the Quadrant, the *Latitude* 51 deg. 30 min. and set those degrees upon the *Meridian* from S, towardes Z to P, which P, shall be the *Pole* of the World; then placing your Compasses upon P, (they being opened to a Quadrant) draw the *Equinoctial Circle* ÆW, which divide into 12 equal Parts; your Compasses being opened as before to a Quadrant, and one Foot being placed in those Marks, made in the *Equinoctial*, with the other Foot describe Circles, which shall be the Hour-lines required; the *Stile* must be erected in P, with an Angle of 51 deg. 30 min. the *Latitude* of the Place; and equal to the length of 60 deg. of the Quadrant, the Top must hang over the Center of the *Hemisphere* Z, and be parallel with the Limb, or erect Stile in the Point Z, of the same length with the former, which shall shew the hour with the Top only.

SECT. II.

How to make a Direct South or North Concave Dial.

THIS Dial is made altogether like the former, only instead of setting off the *Latitude* from to P, you must only set off the Complement of the *Latitude* 38 deg. 30 min. and the *Hour-lines* only from 6 to 6, are described thereon; the

rest of the Hour-lines, are reserved for a *Dire Dial* beholding the *North*.

SECT. III. *Fig.* 1

How to make a Direct East or West Concave Di

LET the *Hemisphere* be ZSNG, the Lin being divided into four Quadrants, and o of them into 90 deg. from N, upwards, and fro S, downwards, set the *Latitude* to P, then ope your Compasses to a Quadrant, one foot being s in P, with the other draw the *Circle* QEA, whi *Circle* divide into 12 equal Parts, your Compass being opened to a Quadrant, one foot placed i each of these marks, with the other draw Circle which shall be the *Hour-lines* required, as i *Figure* 15, The *Stile* may be a *Wire* laid from P P, or a *Wire* erected in the Center E, equal the Semidiameter of the Quadrant; for better I structure see the Figure, which is an *East Dial*.

In the same manner is an Equinoctial Dial mad only all the hours from 6 in the Morning till 6 *Night*, must be drawn, as the rest above tho proper for the *East* or *West* Dials are, and as t pricked hours 9 1 7 and 6, in the Figure.

Also the Hour-line of 6, *viz.* the Line P 6 must be P 12 P, and the rest number'd as in t Figure is expressed, and number'd with *Arit metical* Figures.

SEC

SECT. IV. *Fig.* 16.

to make a South or North Declining Concave Dial.

OUR *Concave* being prepared, quartered and marked with the Letters ZNEW, r Compasses being opened to a Quadrant, one foot in Z or N, draw the *Horizontal* cle ESW, take the Declination, and prick it n in the Horizontal Circle from W to H, one of your Compasses remaining in H, and be-opened to a Quadrant, describe the *Meridian*, our of 12, in which from Z, set off the Com-ent of the *Latitude*, or from it's intersection the Horizontal Circle, set off the *Latitude* , one foot of your Compasses being in P, and ed to a Quadrant, draw the Equinoctial QÆA where it is intersected by the hour of 12, be-to divide it into 12 equal Parts, one foot of r Compasses being placed in each of these s, and being opened to a Quadrant, draw which shall be the Hour-Lines required. For stile, that must be erected in P, and the top of ust pass through the Center, of the *Limb* of *Concave*, and be equal to the length of 60 deg. e Quadrant, or you may erect the Stile, in oint S, the length equal to the former; which shew the hour of the day with the very top

te, This Figure Declines *West*; which if

had declined *East*, the Declination must been set from E.

SECT. V.

How to make a Polar Concave-Dial.

A *Polar Concave-Dial*, is nothing but a *zontal-Dial*, in the *Latitude* of 90 de of all others is most easie to be made, for divide the Limb of the Concave *Hemisphe* 24 equal Parts, and from the Center of th cave, (by help of a thin Ruler that will bend streight Lines to each of them, those shall Hour-lines required.

For the *Stile*, it must be a streight Wire e Perpendicular in the Center of the Concave, shadow will at all Times (the Sun shining the hour of the Day, and the hours of these must be numbred from 12 to 12.

Of The Furniture *in* Concav Dials.

CHAP. XXIII.

SECT. I. How to draw the Parallels Sun's Declination, in the foregoing C Dials.

THE *Equator* being drawn, set off the

idian of the Concave or *Substiler*, both upwards and downwards; then place one foot of your Compasses in the Pole, and extend the other to those you marked from the *Equator*, draw Circles, which shall be the Parallels of the *Sun*'s Declination required; As for *Example*, the drawing of the two *Tropicks*, which declines 23 deg. 30 min. from the *Equator*; take 23 deg. 30 min. and prick it down in the *Meridian* both ways, then place one foot of your Compasses in the Pole, and with the other extended to 23 deg. 30 min. describe the two *Tropicks*; as in *Figure* 14. appears.

SECT. II.

How to draw the Azimuths or Vertical Circles.

DIvide the *Horizon* into 180 deg. beginning where it's intersected by the *Meridian*; if you would draw every 10*th Azimuth*, then you may only divide it into 18 equal Parts, beginning at the same Place; but if you would only draw every 15 *Azimuth*, then divide the *Horizon* into 12 equal Parts, beginning as before at the *Meridian*, if you would draw the Points of the Compass, divide the *Horizon* into 16 Parts, then open your Compasses to a Quadrant, place one Foot in any of those *Divisions*, and where the other Foot intersects the *Horizontal* Line, shall be the Center for drawing that *Azimuth*.

SECT. III.

How to draw Planetary or Unequal Hours.

FOR the drawing of the *Planetary Hours*, ving first described the *Horizon*, *Epua* and the two *Tropicks*, divide that part of *Tropick* which is intercepted betwixt its interſ ion with the Horizontal-Circle, into 12 equal p beginning at 12; the *Equator* being before divi into 12 equal parts by the Hour-lines, open y Compasses to a Quadrant, one foot being pla in one of those Divisions; move the other foot til you find the Center, which will draw b those Points into one Circle; and draw Cir which shall be the unequal Hours required.

SECT. IV.

How to draw Hours from Sun Rise, to Sun Set, led the Italian and Babylonish Hours.

PLace one foot of your Compasses in the P and extend the other to the Intersection the Horizon and Meridian, and describe the rallel of the Latitude, which shall be divided i 24 equal parts by the Hour-circles, place one f of your Compasses in each of those Divisions(Compasses being opened to a Quadrant) the ot foot, being placed within the Circle of *Latit and in the Hour-circle*, which passeth through

P

oints where the Compasses is set in the Circle; making that the Center, describe Circles from one *Tropick* to another, which shall be the Hour-lines rom *Sun rise* to *Sun set*; and shall pass by the nterfection of the Hour-lines and the *Equator*.

SECT. V.

How to draw the Almicanters.

HAving found the *Points* of *Zenith* and *Nadir*, the distance of these Points to the *Horizontal line* into 90 deg. one Foot being placed on one of these *Points*, the other extend to those Degrees, Circles drawn from one *Tropick* to another, shall give *Almicanters* or Circles of *Altitude*.

CONVEX DIALLING.

CHAP. XXIV.

How to make a Dial, upon the Convex Superficies of a Globe which shall shew the Hour, by the Shadow, which separateth the Enlightned Hemisphere *from the* Opacus.

THE Performance of this is very easy, for (the Globe being truly Spherical) if the *Equinoctial Circle*, the two Tropicks, and the two *Polar Circles* which will be necessary for ornament *ly to be* described thereon, and your Equino

Circle (or middle of your *Globe* which i
be divided into 24 equal Parts, and mar
1, 2, 3, *&c.* to 12, aud then beginni
with 1, 2, 3, *&c.* to 12. Then if yo
one of the Poles so many degrees above
zont. *line*, as the Pole of the *World* is
above your Horizon, and place one of
Points, that is marked with 6, to behol
ridian of the Place, then will the two
Clock Hour points behold one the *East*
other the *West* part of the Horizon; and
Sun, at all Times shining upon the *Globe*,
lighten one Hemisphere, and the othe
shadowed, and where the Line of Shado
amongst the Hour-points upon the *Equi*
will shew the Hour of the Day, in tw
viz. one on the *East*, and another on
side of the Globe.

Notes. If you open your Compas
Quarter of the distance, round the *E*
Circle of your Globe, and place one Fo
Marks made in the *Equinoctial*, with t
you may describe the *Hour-lines*, from
pick to the other, or if you will from
to the other.

BLE *containing the* Latitude, *of most he Eminent* Cities *and* Towns *in* Eng-l, Scotland *and* Ireland.

in *England* *Wales.*	D.	M.	Places in *Scotland* and *Ireland.*	D.	M.
DON	51	30	*Rochester*	51	29
	54	00	*Peterborough*	52	33
	51	54	*Chichester*	53	50
dge	52	17	*Hereford*	51	31
ɔ	52	44	*Newark*	53	2
ury	51	27	*Stafford*	52	55
	51	30	*Shrewsbury*	52	48
er	52	4	*Lancaster*	54	8
r	52	0	*Winchester*	51	10
d	52	14	*Leicester*	52	40
uth	51	51	*Pembrooke*	51	46
th	52	45	*Worcester.*	52	20
:k	52	25	In *Scotland.*		
	53	17	*EDENBURG*	55	56
ry	57	0	*Glasgow*	55	52
mpton	52	18	*St. John's*	57	44
?le	54	56	*St. Andrew's*	57	45
ı	53	15	*Sterling*	57	18
gham	53	3	*Berwick*	55	49
	53	2	*Aberdene.*	58	40
	53	20	In *Ireland.*		
eld	53	54	*DUBLIN*	53	11
ry	52	30	*Kingsale*	51	40
	53	6	*Cork*	51	47
d	52	18	*Wexford*	52	18
gdon	52	19	*Waterford*	52	22
then	52	2	Limerick	52	[illegible]
	53	50	Tredagh	53	53
	52	08	Kin's-Town	53	[illegible]

REFLEX DIALLING.

CHAP. XXV.

REflection is to be made by a piece of *Looking-Glass*, which is so much the better, by how much it is thinner; for the Thickness of it causeth a double Ray of Light to be reflected, and requires a greater Elevation of the *Sun's Beams* than a thin one doth: It must be about seven Times the Thickness in breadth; and because *Glass* reflects from upper and nearer *Superficies*, and so makes two *Spots*, colour the lower *Superficies* thereof with *Oyl Colour*, and it will make but one *Spot*.

How to make a Dial *upon the* Cieling *of a* Room, *that is parallel to a piece of* Glass, *placed exactly* Horizontal.

FIRST, determine the most convenient *Point* in the Window where to place the *Reflecting Glass*, as near the *Cieling* as you can conveniently, provided it be not so near as that the Cornish of the Window will shadow the *Glass* when the *Sun* is high in Summer, suppose within 10 or a 11 Inches of the *Cieling*; then find a Point upon the Cieling directly over your *Glass*, *thus*: Hold a Line and Plummet to the *Cieling just over it*, and the Place where the Plumline *touacheth* the *Cieling* is the Point; then through th

is Point draw a *Perpendicular* to your *Window*: Now if your Window be exactly *South*, is Perpendicular upon the Cieling will be a *Meridian-line*; but if your Window declines e true *Meridian line* will make an Angle th this Perpendicular, equal to the quantity of Declination. Therefore having found the clination of your Window, take 60 deg. of ords, and setting one Foot in the Point on the eling, with the other describe a Circle, and thereon (from the Perpendicular) the Denation of your Window, toward your Right-nd if *West*, but toward your Left-hand if *East*; n draw a Line from the point on which you scribe your Circle, which Line shall be your *ridian-line*.

2. Draw an *Horizontal-Dial* upon the back of ne Table, or some Plaister-wall, or Floor.

3. Take the distance between the Glass and *Cieling* with your Compasses; then come to ur *Dial* on the *Wall*, and lay one side of your are to the *Meridian-line*, and the other sing the *Stile*; then move the Square upon *Meridian-line*, till the Extent of the Comses does exactly touch both *Stile* and *Meri-n-line*, and that point of the *Stile* which s touch the Square, may be called the *Glass-t*, from which erect a Perpendicular, and ere it cuts the *Meridian-line* make a Point, ich will be the *Equinoctial Point*, from which erect a Perpendicular, which will be a gent; then at some distance on which side the *Equinoctial Point* you find most conveni-

er

ent, erect another *Tangent*, these two *Tanga* will cut the Hour-lines in the Points, whi may be called the *Hour-Points*.

4. Take the Distance between the *Glass-Pa* and *Equinoctial-Point*, and extend it from t Glass to the *Meridian-line* on the *Cieling*, a where it toucheth, that is the *Equinoctial-Po* upon the *Cieling*.

5. Set off correspondent Tangent-lines up the *Cieling*, and making like *Hour-Points*, throu those Points draw the *Hour-lines*.

6. This Dial is nothing but an *Horizont Dial* inverted, the Center being in the Air, e cept you make a *North Dial*, (which is seldo done) then it will be upon the *Cieling*, whi you may find by its distance from the *Equinoct Point*; then upon that Center describe a Circ and likewise out of that Center erect a Perpe dicular to the *Meridian-line*, for the *Hour-l* of 6; and you have no more to do but to l off from the *Hour-line* of 12, all the other Hou according to their Spaces, in an Horizon Dial.

Lastly, Let your *Dial* on the Wall, remain take Distances for uses at any other Time.

Ch

CYLINDRICAL DIALLING,

EITHER

oncave or Convex.

CHAP. XXVI.

those that fall in a Right Sphere, viz. *such s lie Parallel to the* Axis *of the* World, *and heir* Bases *Parallel to the Equinoctial.*

IOUR-lines may be drawn upon those *Cylinders,* with great Ease and Exactness, alugh in them there may be various Positions the *Axis.*

ect. I. If the *Axis* fall in the very Center the Base of the Cylinder, then divide the Circiference of the Base of the Cylinder, in 24 al Parts, and draw Lines from the Center to h of those Points, which will be the Hours for the Base of the Cylinder: And where se Lines cut the Circumference Lines, drawn n them down the Cylinder's side, they shall the true Hour-lines, which will be Parallel l to one another.

ect. II. If the Point of the *Axis,* fall not in the Center of the Base, of the Cylinder, ' that Point where the *Axis* falls, and the ter of the Cylinder draw a Line, and with a of Compasses take the nearest distance from th

the *Axis point* and describe a Circle, which divide into 24 equal Parts, (beginning at the Diameter first drawn) Lines drawn from the *Axis-Point*, through every one of them, and extend to the Side or Circumference of the Base of the Cylinder, shall be *Hour-lines*, again Lines drawn from them down the side of the Cylinder shall be Hour-lines also.

Sect. III. If the Point of the *Axis* fall in any Part of the *Periferie* of the Cylinder's Base. Then divide the *Circumference* of the Cylinder's Base, into 12 equal Parts, beginning at the *Axis Point*; Lines drawn from thence to the several Points, in the *Periferie* of the Circle, and also down the Cylinder's side, they shall be the Hour Lines.

Sect. IV. If the *Axis Point* fall without the Base of the Cylinder. Then the distance between that Point, and the nearest Part of the *Periferie*, of the Cylinders Base, being made Radius, and a Circle be thereon described, and divided into 12 equal Parts; then Lines drawn from the *Axis Point*, through those Divisions shall each of them cut the *Pereferie* of the Cylinder's Base, in two Points, from which Lines drawn from one to another (each to this correspondent) they shall be the Hour-lines, and from them Point-lines down the Cylinder's side, must parallel Lines be drawn. Also,

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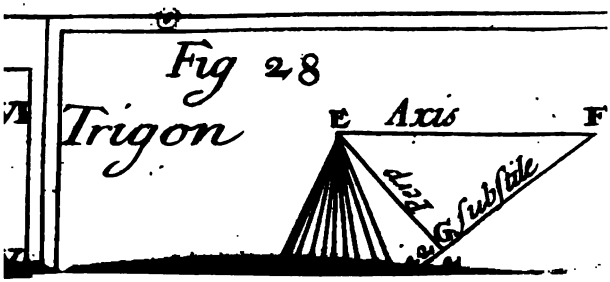


Fig 28
Trigon
E
Axis
F
Lex
G
Subsile

of the Furniture *with which*

Sun-Dials

lay be BEAUTIFIED;

And

describe such Furniture upon all Sorts of ht, Direct and Declining Dials, Geome- ly.

CHAP. XXVII.

Circles of the Sphere, as are described Sun-Dials.

Any Astronomical Conclusions, may be per- formed by describing of the *Circles* of ere upon *Sun-Dials*: Of which I have oice of these following.

e Parallels of the Signs, shewing in what the *Zodiack* the *Sun* is, at all times of the

e *Diurnal Arches*, shewing the length of throughout the Year.

e *Hours* from the Sun's Rising or Setting, ways called the *Babylonish* and *Italian*

e *Jewish* Unequal, or Planetary Hours.

5. The *Azimuths*, shewing in what qua
the World, or upon what Point of the (
the *Sun*'s on at all times of the Day.

CHAP. XXVIII.

How to describe the Equinoctial, *the two* Tr
and other Parallels of Declination, up
Sun-Dial.

THE two *Tropicks*, being the Bounda
the *Sun's Course* (for he never e
those Limits,) therefore it is best, *first* to
how they may be described for betweer
all other *Circles* (either Great or Small
be Projected, and the manner of describin
upon several Planes various.

SECT. I.

On the direct East, *or* West, *and* Equi
Dials.

LET an *Example* be of direct *East* D
the *Latitude* of 51 deg. 30 min.

How to describe the Hour-Lines upo
Planes, is shewed in the 4*th* and 7*th* Cha
this Book. Therefore such a *Dial* being
as in *Figure* 25, through the Foot of t
pendicular Stile, as at E, draw a Line ME
rallel to the Horizon; for the Horizontal
all Planes, must be drawn through the
the Perpendicular Stile, and also thro

Point where the Equinoctial Circle crosseth the Hour-Line of *Six*. Your Dial, with the Equinoctial Line hereof, HES, being drawn, we come to describe the *Tropicks*.

1. Upon a piece of fine Card-past-board, draw the Line O R, as in *Figure* 26, representing the Equinoctial Line in your Dial; and (because the *Tropicks* are 23 deg. 30 min. distant from the Equinoctial) with 60 deg. of your Line of Chords, upon the Point O, describe an Arch of a *Circle*, and set upon it 23 deg. 30 min. from R to S, and draw the Line O S, representing the two *Tropicks*; and the Angle S O R, you may call a *Trigon*.

2. Out of your Dial take the length of the *Perpendicular Stile* E G, and set it upon your *Trigon* from O to P, and draw the Line P 6 *Perpendicular* to O R. Also,

Take the distance from G, *to the Intersection of the Hour Line of*	7 8 9 10 11	*with the Equinoctial, and set it upon the* Trigon, *from* O, *to*	*q* *r* *s* *t* *v*	*and draw the Lines*	*q* *r* *s* *t* *v*	7 8 9 10 11	*perpendicular to* O R

Thus having prepared the *Trigon*, out of it take the distance P 6, and set it upon the 6 a Clock *Hour* line, from E to *c*: Also take the distance *q* 7, and set it upon your Dial from V to *b*, and from VII to *d*: Also take *r* 8, and set it upon your Dial from IV to *a*, and from VIII to *e*; Likewise take the distance *s* 9, and set it on your Dial from IX to *f*: Also, take *s* 10, and

set it on your Dial from X to *g*; Lastly, *v* 11, and set it on your Dial from XI to *b*.

These *Points* *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, are *Points* through which the *Tropick* of *Cancer* be described; therefore if through them a be drawn with an even hand making no An that shall be *Tropick* of *Cancer*.

The *Tropick* of *Capricorn* may be desc in the same manner, for if from your *Trigon* take

The distance	*r* 8	And set	VIII
	s 9	it upon	IX
	t 10	your *Dial*	X
	v 11	from	XI

Those shall be the *Points* through whicl *Tropick* of *Capricorn* must be described; tl fore if through *k*, *l*, *m*, *n*, a Line be drawn an even *Hand*, it shall be the *Tropick* of C *corn*: And,

When the Sun is in	*Capricorn*, *Aries*, *Libra*, or *Cancer*,	which is about	*Decem.* 11	the Sh	
			March, 10	of the t	
			Sept. 12	the *Stile*	
			June. 11	pass alo	
				those r	
				tive Li	

And according to this Method, may any c intermediate Parallels of *Declinatioa* be inse as for Example: Suppose I would insert the rallels of the *Sun*'s entrance into the 12 S *Aries* and *Libra* are inserted already, also C and *Capricorn*; for the rest, as when the S *ters into*

s,	the *Sun* hath 11 deg. 30 min.	of Declinations.
o,		
,		
i,	the *Sun* hath 20 deg. 12 min.	
arius		
ius		

erefore take 11 deg. 30 min. and 20 deg. in. out of your Line of Chords, and set upon the Arch RS of your *Trigon*, from R and X, and draw the two Lines OV and

ese Parallels, being thus put in your *Tri-* ney may be transferr'd into the Dial, in all cts as the *Tropicks* were; and as you see in *Fig.* 26.

SECT. II.

a direct South *or* North-Dial. *Fig.* 27.

AVING drawn your Dial, as is taught in Chapters 2, 3, or together with the your first work must be to proportion stile to your Dial; which to do, assume onvenient Point in the Substile (here the of XII) for the farthermost *Tropick*, as he Point ♋; then the Stile's height being g. *30 min.* add 23 deg. 30 min. thereto. n *is 62* deg. and that is the Meridian A f *the* Sun when he enters Cancer,

the Complement thereof to 90 deg. is 28 de
Therefore, upon the Point *Cancer*, make an A
gle B ☋ A, to contain 28 deg. so shall the Li
☋ A, cut the *Axis* of the Stile O A, in A; th
from A let fall a *Perpendicular* to O ☋, as A
and so is your Stile proportioned to your Di
and the Line C B D (being drawn Parallel to t
Horizon, through the Point B) shall be the
rizontal Line of your Dial.

This done, prepare a *Trigon*, as *Figure* 28,
which make E F equal to O A, and F G equal
O B, and *E* G, to AB; the *Triangle E FG*,
the *Trigon*, equal to the *Triangle* of the St
O A B, in the Dial.

From the Point *E*, draw a Perpendicular
E F, as *E* 12, for the *Equinoctial*; and upon
wtih 90 deg. of Chors describe the Arch *H*
L, and upon it set 23 deg. 30 min, from 12
H and *L*, and draw the line E H for the T
pick of *Cancer*, and E L for the *Tropick* of
pricorn: Draw the Substiler Line F G, qu
through the *Trigon*, crossing the *Equinoctial* ir
and both the *Tropicks*.

This done, out of your *Trigon* take the
stance from *F* to *a*, and set on your Dial fr
the *Center* O to *c*, through which Point draw
Line ♈ *c* ♎ for the *Equinoctial*: Then from
the *Center* of your Dial, take the distance to
Intersection of the *Hour-Line* of 11, or 1 w
the *Equinoctial*, and set it on the *Trigon*, from
to *b*: Also take the distance from *O*, to the
rersection of the *Hour-line* of 10 or 2, and
it from F to c: Likewise take the distance fr
to the Intersection of the Hour line of

and set it from F to *d*: Lastly, the distance
m O, to the Intersection of 8 or 4, with the
inoctial, set from F to *e*; and draw the Lines,
, *Fb*, *Fc*, *Fd*, *Fe*, through the *Trigon*, ma-
g them 12, 11, 10, 9, 8, and 1, 2, 3, 4,
. Now to find the Points upon the Dial,
ough which the *Tropicks* must pass:

e Dist	12	will reach	♋	on the	12		
e from	11	from O,	*f*	*Hour*	11	1	
	20	the *Center*	*g*	*Lines*	10	2	
	9	of the *Dial*	*h*	of	9	3	
	8	to					

Through which Points the *Tropick* of *Cancer*
t be drawn with an even Hand: And,

e Dist-	12	will reach	♑	upon	12	12
e from	1	from O,	*k*	the	11	1
	2	the *Center*	*l*	*Hour*	10	2
	3	of the *Dial*	*m*	*Line*	9	3
	4	to	♑	of	8	4

hrough which Points the *Troprick* of *Capricorn*
t be drawn. And thus you have the *Equino-*
, and the two *Tropicks*, described upon a
& South Dial.

SECT. III.

How to describe the Equinoctial, and the two Tro picks, *on any Upright* Dial *Declining, or in su as both* Recline *and* Decline.

AN Example of an Upright Dial declini from the *South Westward* 30 deg. Th making of these *Dials* is Taught in the fif and eighth or twentysixth Chapters of this Boo Therefore having drawn such a Dial, and th Stile and Substile in a due Position, you will fi the Height of the Stile to be 23 deg. 37 mi First, make an Horizontal Dial for the Latitu of 32 deg. 37 min. as in the Declining Di *Fig.* 27, where the Substiler-line is taken f the Hour-line of 12, as it is there marked, a the other Pricked-lines, are the Hour-lines of Horizontal Dial for the Latitude of 32 deg. min. Now, if according to the Directions the foregoing Sections you make *Trigon*, a insert the *Equinoctial*, and *Tropicks*, and afte wards expunge the obscure Lines of the *Horizo tal-Dial*, the *Equinoctial Tropicks*, and the *Ho zontal-line* will be the same, as if they had be inserted from the true *Hour-lines* belonging to t *Dial-Plane*.

And as the *Tropicks* were described, so lik wise may the Parallel of the Sun's Entran into the other Signs, be inserted if into your *T gon*, you put there *Arches* of Declinations fro *the Equinoctial*, Namely, 11 deg. 30 min. a

5 deg. 12 min. And so are the Parallels of the Signs put into the Dial, *Fig.* 29.

And in any Dial, also may the Diurnal Arches be described, if you put into the *Trigon* such Declinations, as the Sun hath from the Equinoctial, when the Days is either,

				deg.	min.	
18		16		23	30	So are the Diurnal Arches put into the *South* Dial represented by the *pricked* Lines there, in
13		15	Hours	21	40	
9	or	14	long,	16	55	
10		13	as,	11	37	
11		12		5	55	
12				0	0	

Fig. 27, and the *Trigon* thereunto belonging is *Fig.* 28.

CHAP. XXIX.

How the Hours from the Sun's Rising *and* Setting, *are to be described into all Sorts of* Sun-Dials.

THE *Hours* from *Sun-rising*, are called the *Babylonish Hours*, for they begin their Day at the *Sun's Rising*: And the *Hours* from *Sun-Settting*, are called the *Italian* Hours, for in *Italy* they account their Time from the Setting of the Sun the Day preceding.

The manner how to describe the *Hours* (is the same in all Planes, and) is easily performed. And because that upon a full *South*, or *Horizontal Dial*, they will appear most Uniform; I have therefore made choice of a direct *South Dial*, as in Figure 27. to describe them; Your *Dial* being drawn, and the *Equinoctial* ♈ ♎, the two *Tropicks* ♋ ♋, and ♑ ♑, and the Horizontal-line *Sun-Rise* —— *Sun-Set*; you must (by the last Chapter) describe two obscure Parallels of Declination, one when the Day is 8 Hours long, as ☉ 8 ☉, and the other when the Day is Sixteen Hours long, as * 16 *, the *Equinoctial* being the Parallel when the Day is Twelve Hours long.

Being thus far prepared the Inscription of these Hours will be very easy; for it it is plain, that when the Day is but 8 Hours long, that the *Sun* Rises at Eight in the Morning; and the first Line after the *Sun's* Rising is Nine in the Morning; also when the Day is 12 Hours long, the *Sun* Rises at 6 in the Morning, and the first Hour after, is 7 in the Morning; Lastly, when the Day is 16 Hours long, the *Sun* Rises at Four in the Morning, and the next Hour after is Five in the Morning: And all the rest as in this Table. Therefore, a streight Line drawn through the Intersection of these Hours Lines, with the Parallels of 8, 12 and 16 Hours, shall be the First Hour after the *Sun's* Rising all the Year long.

n like manner, if you uld insert the seventh r the Sun's rising: By Table you see, that the allel of viii Hours, for length of the Day, the venth hour from Sun-rising is 3 in the Afternoon, erefore observe where e Hour-line of 3 crosseth e Parallel of viii Hours, hich is at *a*. Also by the able you see that in the arallel of xii Hours, for e length of the Day, the

	Length of Days.		
	viii	xii	xvii
Hours from Sun-rising. i	29	7	5
ii	10	8	6
iii	11	9	7
iv	12	10	8
v	1	11	9
vi	2	12	10
vii	3	1	11
viii	4	2	12
xi	5	3	1
x	6	4	2
xi	7	5	3

venth Hour from Sun-rising is 1 in the Afternoon; therefore observe where the *Hour-line* of crosseth the *Equinoctial*, which is at *b*. Thirdly, y the Table you see, that in the Parallel of xii ours, for the length of the Day, the seventh lour from the *Sun's Rising* is 11 in the Forenoon; and therefore observe where the *Hour-line* f xi crosseth the Parallel of xvi Hours for the ngth of the Day, which at *c*; so shall a right-ne drawn through these Points, *a*, *b*, *c*, be the venth Hour after the *Sun*'s Rising throughout he Year: And thus by the help of this Table, ou may draw all the Hour-lines from the *Sun*'s ising, as you see them drawn, and numbred as *Fig.* 27.

In the same manner, as the Hours from the *n's Rising* (which are the Babylonish Hours) we *wn*, may the Hours from the Sun's Set

(which are the *Italian* Hours) be drawn: T
difference being only in the numbring of the
the hours from *Sun* Rising, being numbred fr
the *West* end of the *Horizontal-line*, by 1, 2,
4, 5, 6, 7, 8, 9, 10: And the *Hours* from S
Setting, from the *East* end of the *Horizontal-l*
backwards, by 23, 22, 21, 20, 19, 18, 17, 1
13; as appears in *Figure* 27.

A Corollary arising from the Work of this Chapte.

The Hour-lines from *Sun* Rising and Settin
being described upon any *Dial*, as is before taugh
there will by their correspondent Intersections on
with another, be Points produced, through which
if Lines be drawn, with an even hand, the sam
shall be the Parallels, of the length of the Da
and such are pricked Lines in *Fig.* 27, numbre
upon the *Meridian-line* of the Dial, by 8, 9
10, 11, 12, 13, 14, 15, 16.

CHAP. XXX.

Of the Jewish, *or Old Unequal, or Planitary hour*
and how they may be described upon any Su
Dial.

THE Ancients, account of their Day, wa
from the *Sun*'s Rising in the *Morning*, till it'
Setting in the *Evening*, which space of time the
did divide into Twelve equal Parts, were it long
or short; so that in the Summer, all the Ti
hat the Sun hath North-Declination, th h

ir Day, was longer than a Common equal ; and in the *Winter* when the *Sun* hath *South* nation the Hour of their Day were shorter a Common equal *Hour*; but when the *Sun* he Equinoctial, their Hours are equal to our ion Hours.

e Inscription of these Hour-lines, into all of *Sun-Dials* is very easie, being much like nscription of the *Italian* and *Babylonish* Hours, ht in the last Chapter.

ving drawn your *Dial*, with Hours, halves, uarters; and also the *Equinoctial*, the two *ks*, and Horizontal-line; and also the *Pa-* of the length e Day, as is in *Figure* 28, h a *South Dial ning Eastward* eg. you must choice of two *llels* of the h of the Day, h must be both mbe equi-di- from the *Equi- l*, which let e *Parallels* of *ours*, and 15 , for those *Parallels* are convenient this purpose

The Jewish.	*The Parallels of* 15 H.		*Equinoctial.*	*The Parallel of* 9 H.	
H.	H	M.		H.	M.
i	5	45	7	8	15
ii	7	00	8	9	30
iii	8	15	9	9	45
iv	9	30	10	10	00
v	10	45	11	11	15
vi	12	00	12	12	00
vii	1	15	1	0	45
viii	2	30	2	1	30
ix	3	45	3	2	15
x	5	00	4	3	00
xi	6	15	5	3	45
xii	7	30	6	4	30

se the Jewish Hours. in those Parallels will just

justly fall upon the even *Hours*, halfs, or quarte
Now the Points through which the *Jewish* ho
are to be drawn, as the Table before will dire
wherein you see, that the first *Jewish* Hour is
be drawn through 5 Hours, 45 min. in the P
rallel of 15 Hours, through 7 in the *Equinocti*
and through 8 Hours and 15 min. in the Par
of 9 Hours: In like manner the second *Je*
Hour must be drawn through the intersectio
7 Hours, in the Parallel of 15 Hours, thro
8 in the *Equinoctial*; and through 9 in the par
lel of 9 Hours: And so must all the rest of th
be described as the Tables does direct, and as y
see done in *Figure* 30. And in this manner,
the help of this Table, may they be described
all sorts of Planes, whither Direct Reclining,
Declining.

CHAP. XXXI.

How the Azimuth must be described, upon a Sun-Dial.

THE *Azimuths* are great Circles, and b
ing projected upon all Dials, becom
streight lines; and they are variously describ
according as the Dial-Plane is scituated, Partic
lars of which follow.

SEC

SECT. I.

On an Horizontal Dial.

IN these Dials the *Azimuths* are most easily described: for, your Dial being drawn, with ie *Tropicks* thereon, you have no more to do, ıen upon the foot of the *perpendicular* Stile as r O (in Figure 31.) as a *Center*, to describe a *ircle*, as ♋, N♋, which you may divide into 2 equal points (beginning at N) answering to ie 32 points of the *Mariner's Compass*, or else ou may divide into 90 equal parts or degrees, oted with ***, *&c*, and through those points raw streight Lines from O, the foot of the *perpendicular* Stile, and they shall be the true *Azimuth* upon an Horizontal Dial, which you may enominate by South S, *by* E, S.S.E, S.E. *by* S, *&c.* s you see done in Figure 31.

SECT. II.

'pon a Direct East, or West Dial. *Fig.* 251

HAving made an East Dial and therein inserted the *Equinoctial*, and the two *Tropicks*, and ıe *Horizontal Line*, you mry proceed to describe ıe *Azimuths* in this manner;

Upon the point E, of the Horizontal Line of *ıur Dial*, MEN, erect the Perpendicular E C *ıal to EG* (the height of your Stile of yo

Dial) and upon Q, as a Center, describe th
Quadrant QEL, and divide it into eight eq
Parts, representing one quarter of the *Mari*
Compass, and from Q through those Points, dr
Lines to the *Horizontal-line* MEN, as ⊙⊙⊙
from which Points let fall Perpendiculars fr
the Horizontal-line, and they shall be the *A*
muths between the *South* and the *East*; and
those Points which fall between the *East* and
North, as E. by N. — E. N. E. — N. E. by N.
are the same Distances set upon the *Horizo*
line from E, towards the Left-hand, as the
three *Azimuth*'s towards your Right-hand, is
⊙⊙⊙; through which Points, if Lines be dra
perpendicular to the Horizontal-line, they sh
be the *Azimuths*, or points of the Comp
between the *East* and the *North*: As in *Fig.* 2
And as the *East-Dial* contains the *Azimuths* b
tween the *South* and the *East*: The *West-Di*
must contain those between the *South* and t
West.

SECT. III.

Upon the Direct South Upright Dial. *Fig.* 2

THE Dial with the Equinoctial, and the tw
Tropicks and the Horizontal-line describ
thereon, the *Azimuths* may be inserted there
as followeth.

First, Take the length of the *perpendicular* Sti
of your Dial AB, and set it upon the *Meridian*
your Dial from B to G.

Seco

condly, With the distance GB, upon G, ibe the Circle EBF, which divide into 16 l Parts (if you will) but I have here divided t into 8, to shew the manner of the Work, ne Points ****, *&c.* Through which ts from G, draw obscure Lines extending i till they touch the Horizontal Line of your CBD, now if from these Points of touch- you draw Lines perpendicular to the Hori- al-line between the *Tropicks*, (or Parallels e Line of 12,) they shall be the *Azimuth* ired.

ote, I have not drawn the Lines themselves is *Fig.* 27. because the Dial is full enough of already.

SECT. IV.

Upon the South Declining Dial. *Fig.* 30.

N Example shall be of a *South-Dial*, Declining Eastwards 15 deg.

ich a *Dial*, being drawn, and the *Equinoctial icks*, and the *Horizontal-line* inserted there- Upon the Point B of the Horizontal-line t the *Perpendicular* BC, equal to BO, the *ndicular Stile* of your Dial; upon which t C, describe the Semicircle RBS, which e, lay a Ruler to C, and the *Point* ☉, where *Hour-line* of 12 crosseth the *Horizontal-line*, where the Ruler cuts the Semicircle RBS, at *Point* begin to divide it into 16 equal parts, ne *points* ***, *&c.* And from the Center *raw Lines* obscurely thro' those points, e ten

tending them till they touch the *Horizontal line*, DE, in the Points *a b c d e f g h i k* and *l*, through these Points Right-lines being drawn, parallel to the *Meridian*, shall be the *Azimuth* desired, which you must number according to the *Scituation* of the *Plane*: Namely, The Western *Azimuths* on the *East* side of the *Meridian*, and the *East Azimuths* on the *West* side of the *Meridian*, as you may see in *Fig.* 30.

CHAP. XXXII.

Of the Meridians of other Countries, and how to insert them into any Sun-Dial.

IT is easy to insert the *Meridian* of any other *Country* into any *Sun-Dial*, made for any other Place; if first you know the difference of *Longitude*, between the two *Countries*, in Time; and also, whether the Remote *Country* lie *Eastward* or *Westward*, from the *Home Country*: For,

If the Remote *Country* lie *Eastward* of the *Home Country*, it is *Noon* sooner than it is at the Place the *Dial* doth stand in; if it lie *Westward*, then it is *Noon* later.

As for Example,

Suppose that in a Sun-*Dial* here at *London*, you would insert the *Meridian* or *Noon-tide* of *Constantinople* by the best *Geographers*, the *Meridian of Constantinople* lies *Eastward* of the *Meridian of London*, 30 deg. 45 min. which converted into *Time by* allowing 15 degrees to one hour, and deg

degree to 4 minutes of Time, it is 2 hours and 15 min. that is 2 hours and a quarter. Wherefore if you subtract 2 hours 15 min. from 12 hours, the Remainder will be 9 hours 45 min. or 3 quarters of an hour. Therefore upon a *Dial* here at *London*, you write the word *Constantinople*, upon the *Hour-line* of 9 and 3 quarters, (or make this *,) the shadow of the Stile of the Dial, when it shall fall upon the Word or Mark, you may conclude it to be *Noon* at *Constantinople*; and knowing that, it is easily known what hour it is at any Time of the Day.

You have several Countries inserted in the *Direct South Dial.* *Fig.* 5.

CHAP. XXXIII.

The manner of Cutting divers Bodies in Wood or Stone, and making Dials upon them.

THERE are seven Bodies usually cut in *Stone* or *Wood*, whereof five of them are called Regular Bodies, because they may be inscribed in a Sphere: And they are also called the five regular *Platonical* Bodies, because *Plato* was the Inventor of them, and are as followeth, the *Cube*, the *Tetrahedrum*, the *Octohedrum*, the *Dodecahedrum*, and the *Icosahedrum*, the others are one of Twelve *Rhombs*, and the other of Thirty *Rhombs*: And the *Cube* is the Mole or Lump, out of which the rest are contrived I shall begin with that first.

How to cut the Cube.

[*Definition.*] A *Cube*, is a solid Body comprehended by Six equal Squares, as are A, B, C, D; A, D, E, F, and D, C, F, G. ——The cutting of this Body is plain by the Definition; for let every side of every square be equal, as A, B, to D, F, A, E, to C, G, *&c.* and you will make a *Cube* of what greatness you will, this Body is capable of five ordinary *Dials*, the fixt square being the Base to stand upon: wherefore if you set the side A, D, E, F, *South*, then will the side opposite thereto be *North*, D, C, F, G, *East*, and the side opposite will be *East*, and A, B, C, D, Horizontal, all which *Dials* are made in the former part of this Book: But if you place any of the Angles of the Horizontal Squares *South*, then will every side decline 45 deg. for if you turn the Angle D, *South* then will the *Diagonal* Line A, C, be *East* and *West*, and the side C, D, F, G, will be a South Declination, *East* 45 deg. and his opposite a *North* declining *West* 45 deg. and A, D, F, E, is a *South* decl. 45 deg. *West*, and his opposite a *North* declining 45 *East*, all which *Dials* are made by the Direction in this Book.

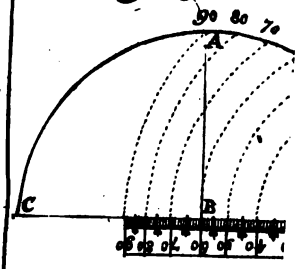
How to cut the Tetrahedrum.

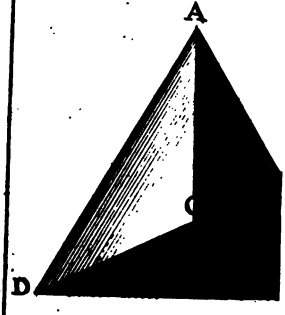
[*Definition.*] The *Tetrahedrum*, is a solid Body comprehended by four *Equilateral Triangles*, as *ACB*, *ACD*, and DCB.

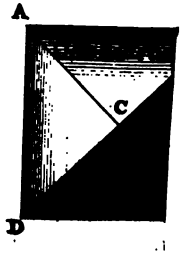
To cut this Body, you must make a Parall

page 164

Fig. 25







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To

ipedl. Let the Breadth AD, be 10000, and he Height AE, be 8164, and the length AB, e 8660, upon the upper Face and Base thereof raw to opposite *Equilateral Triangler*, as ADH, ivide the *Perpendicular* PH, into three Parts, and et one part thereof which is equal to 2886, from to N, and from D to L, draw the Line NL, nd in the middle of the point R, will be the ertex of the Solid ABD; From the Point L the Angles F and G, draw to streight Lines F, and LG; do the like on the opposite side y the point N; cut off the two *Triangular Pooms* L, D, E, N, A, E, and G, L, C, N, B, so will here remain the solid Body called a *Prisma*, hose two sides FLG, and the Opposite, are qual *Triangles*, the other three sides L, F, N, E, c. are *Paralellograme*. Next by the Points F, , H, and the side of the *Triangle* FH, drawn in e Base; as also by the Points EKH, and the her side of the *Triangle* EH, cut this *Prisma*, nd their come forth the Solid Body A, C, D, B, e *Tetrahedrum* desired. The Body thus prepared t the Angle A *South*, then will the side BOD, the *North* Reclining 19. 28 and the other two les AOB, and AOD, will be *South* Decliners deg. and will recline as the former. The aking of these Dials is Taught in the former rt of this Book. The Requisites and Hour istances are as followeth.

North Recl. 19. 28. *the Complement of the Lat.* add 38.28. *The St. heig.* 57.56.			*Hours from the Subſtile.*	*True Hour diſtances.*		*Hours from the Subſtile.*
Direct North Reclining.			*South-*	*Declin.*		*Reclin.*
				D.	*M.*	
Hours from the Meridian.	*True Hour diſtances.*		3	10	36	9
			4	04	00	8
			5	02	13	7
			6	01	11	6
			7	00	41	5
Hours.	*D.*	*M.*	8	00	10	4
			Subſtile.			*Subſtile.*
12	00	00	9	00	19	3
11 1	12	48	10	00	51	2
10 2	27	04	11	01	32	1
9 3	40	17	12	00	37	12
8 4	55	44	1	00	00	11
7 5	72	28	2	19	26	10

The other two *South* Reclining Declining have the ſame *Dials* ſerving for both; changing but the Poſition of the Subſtile and Hours as hath been directed. The Requiſites of the foregoing Table of *South* Declining Reclining are as followeth.

The Planes Reclination — — — 19 28
The Planes Declination Eaſt or *Weſt*, 60 00
he diſtance of the Mer. and Horizon, 60 0
he Stiles Height above the Plane. 01

The *Substiles* distance from the *Meridian* — 02 36
The *Planes* Longitude — — — 34 46
Therefore the Substile falleth between 8 and 9 of the Clock in the *East-Dial*, and between 3 and 4 in the *West*.

The best way of making these two Dials will be by the Polar Scales as you did the far Decliners.

How to cut the Octohedrum.

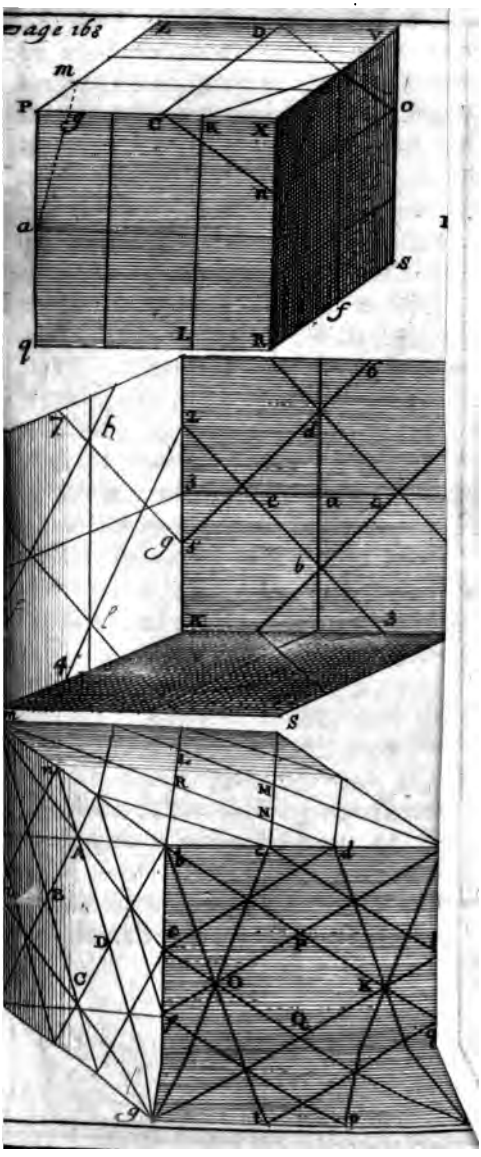
An *Octohedrum* is a solid Body, comprehended of eight equal *Equilateral Triangles*, as are ACB, ACD, BCE, and ECD; To cut this Body you must take a *Parallel piped* BEFC, let the breadth thereof BC, or AD, be 10000, and the height thereof AE, or CG, be 8164, and the length thereof BA, or FG, be 11547, let AI, and DK, and LC, be 2887, one fourth (or a quarter) of AB, or FG, by which draw the Line IK, upon the Superficies, and the like by L, in the Base, make equilateral Triangles IKH upon the Superficies, and from the Point L in the Base the like, so that the Point N of the Triangle in the Base may be opposite to the Point H, of the Superficies; draw the Lines KF, KL, and LC, on the one side of the Figure, and the like on the other side, cut off the *Triangler* portion IKFE, downwards, and the opposite to it LGCB, upwards, and there will remain two equal Oblongs KIBHC, and LFNE, the Base inclining from the Line BHC, as much as the Superficies doth decline from the Perpendicular of NEF, next

off the Portions LKH, and IH, above, LKN and IN, by the *Triangle* beneath, so shall you have at six cuts the solid of eight equilateral *Triangles* ABCDE, desired. The Body thus prepared, and the same Dials of the *Tetrahedrum*, will serve for the *Octohedrum* also; for the Plane BCE, will be a *South* Incliner, and its opposite a *North* Reclining 19. 28, and the Plane DAC, and ECB, will decline 60 deg. and recline as the other, and their opposites Declines and Inclines, 60 deg. as may be seen by Bodies themselves, joyning to the Reclining side, BCD, of the *Tetrahedrum* to the Inclining side DCE, of the *Octohedrum*, will plainly demonstrate the same, the Dials being the one and the same in both, there will not be any need to reiterate the Work over again.

How to cut the

DODECAHEDRUM.

THE *Dodecahedrum* is a solid Body, comprehended of 12 equilateral Pentangles, as HSRVO, HSBA, and HOES, *&c.* To cut this Body, you must first make a Cube; as is PRSV, divide each side into halves, as P q, at, a. b. R. S, at f. o, and X. P. as C, D, let each half P. a, X. o, and R. f, be the *Radius*, or *10000 divided* by extream and mean Proportion *P. g*, X. *n*, and V. o, shall be 6180, the gre


Page 168
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th
o

H
cu
is
at
ea
10
P.

r Segment, and g, c, and n, b, be 3820, the lef-
:r Segment, and so must the rest of the sides
e also divided, but with this Caution, that the
iddles and segments of every side Contermi-
ous be drawn cross to others, as those of P, q,
:. X, cross those of X, R, and S, V, and they
gain cross to them of P, X, and V, Z, yet every
pposite side Parallel to each other, from the
uarter Segment of the one side, to the middle
ine of the other, draw streight Lines cross the
Body, as are n, C, K, o, and o, b; cut off each
Triangular *Prisma*, viz. n, o, D, C, L, K, f, o,
nd m, o, b, a; and so of the rest. And so shall
ou at twelve Cuts, frame the *Dodecahedrum*,
onsisting of twelve *Pentangles*, as is represented
y the *Figure*: The Body being thus prepared,
et the Angle H, of the Horizontal Plane *H R S*,
O, *South*, then shall the five superior Planes
ecline, and their Opposites incline as much, *viz.*
VDKC, will be a direct *North* reclining 26
leg. 33 min and V O D E, and *RSBC*, two
North reclining as much, and declining also 72
leg. *HOEA*, and *HSBA*, two *South* recli-
ning as much, and declining 36, the Reclination
of the five Planes being the same.

Having the Reclination of the direct *North*
Dial, it is to be made as you have been Taught
n the foregoing *Chapters*, whose hour distan-
es, for all the Planes are as followeth.

Direct North, Reclining 26 23 Stiles height 65 01				North Reclining 26 33 Declining 72 00				South Reclining 26 33 Declining 36 00			
				Hours		Hours on the Plane.		Hours		Hours on the Plane.	
					12	82	05	04	08	71	42
				1	11	56	22	05	07	18	13
Hours		d.	m.	2	10	37	35	05	06	09	07
				3	9	24	18	07	04	05	21
12		•		4	8	14	12	08	04	03	03
11	1	00	09	5	7	05	33	09	03	01	02
10	2	13	38	Sub-		stile		Sub-		stile	
9	3	27	38	6	6	02	10	10	02	00	11
8	4	42	12	7	5	10	17	11	01	01	44
7	5	57	30	8	4	19	30	12		03	34
6	6	73	32	9	3	31	07	01	11	06	06
		90		10	2	47	09	02	10	10	34
				11	1	59	51	03	09	23	15

Note, The *North* Recliners and their Oppoſite declining 72 deg. have the ſame Dials ſerving for all four, changing the Poſition of the *Stile* and *Hours*, as before was directed; and are to be made by the *Rules* of the foregoing *Chapter*. The Requiſites for both the reclining declining *Dials* are as followeth.

Firſt, *For the* North *Dial declining* 72 *deg.*

North Reclining 26 2
Declining East and *Weſt* 72 0
The diſtance of Meridian and Horizon 36

ıe Subst. distance from the Mer.	82	04
ıe Plane's difference of Longitude	85	50
ıe Stile height	31	28

Secondly, *The Requisites for the* South *declining* 36 *deg.*

arth Reclining	26	33
eclining *East* and *West*	36	00
he Distance of the *Mer.* and *Hor.*	72	00
he *Substiles* distance from the *Meridian*	03	33
he *Planes* Difference of *Longitude*	31	33
he *Height* of the *Stile*	05	44

How to CUT

The ICOSAHEDRUM.

THE *Icosahedrum* is a Solid, comprehended of twenty equal *Equilateral* Triangles, as are *l*, *b*, *C*, *A*, *b*, *d*, *A*, *E*, *C*, *G*, *b*, *f*, &c. There e two ways to cut this Body; the one is the ry same as the *Dodecahedrum* was cut, drawing e Parallel Lines upon the Cube, at the distance the lesser *Segment*, as there you drew them om the greater *Segment*.

The other way is thus; divide each side of the ube *p*, *q*, *r*, *X*, into half, and draw streight nes crossing at right Angles, as *b*, *d*, *c*, *e*, *h*, *l*, d *f*, *g*, and *k*, *m*, and *l*, *n*; then making *p*, *a*, *o*, *a*, half the side, the *Radius* 10000, let *a*, *c*, e *greater Segment* 6180, be set from *a*, upon h *middle* Line to cross *b*, *c*, *d*, *e*, and *b*, *g*, *f*

l, g, &c. draw streight Lines crossing each o
at right Angles round about the Cube, so t
you have eight *Equilateral* Triangles, such
are 2, 3, 4, and 5, 6, 7, *&c.* by which every o
ner being cut off, their will remain six Squa
as *b, c, d, e, g, h, f, l, k, l, m, n,* and eight S
angles; then shall *b, d,* be the Base, and the Po
g, of the next Square the Vertex to cut out
Triangle *b, d, g,* and *g, i,* shall be the Base,
K, the Vertex to cut out the Triangle *g, i, k,*
K in the Base and *b,* the Vertex to cut out *K,*
and these three being cut, will leave a fou
Triangle between them *K, b, g;* and so of
rest till you find the Body come forth.

The Body being thus prepared, let the An
C, of the *Horizontal A, b, C, South,* then sh
A, b, d, be a direct *North* Reclining 48 deg.
min. and the opposite Inclining as much, *A, C,*
and *C, b, f,* are two *South* Reclining as much,
Declining 60 deg. The other six *Contermin*
with the three do all Recline alike 19 28, whe
of the two *South g, C, E,* and *g, e, f,* do a
Decline 22 14, the two backward *North*
Planes *K, b, d,* and *n. A, d.* do decline 37 d
45 min. and the two intermediate *North* Pla
b, K, f, and *A. n, E,* do also decline 82 14, a
as these do, so doth their opposites decline, a
recline as much. These Things being consider
and the Body being prepared, the *North* re
ning Dial 48 deg. 11 min. is made accordi
to the foregoing *Chapters.*

Here followeth a *Table* of all the Hour distan
of all the Planes belonging to this Body, with
equities of the Reclining declining Planes.

North Reclining.				South Reclining.				South Reclining.			
48 11				48 11				22 14			
Stiles height				Declining				Declining			
86 39				60 00				22 14			
Hours.	Hour distances			Hours		Hours on the Plane		Hours.		Hours on the Plane	
				4	7	68	13	5	8	66	58
12	0	0		5	6	40	48	6	7	35	8
1	1 14	59		6	5	25	17	7	6	20	37
0	2 29	57		7	4	15	32	8	5	12	30
	3 44	57		8	3	08	25	9	4	6	53
	4 59	57		9	2	02	26	10	3	2	19
	5 74	59		Sub-		stile.		Sub-		stile.	
	6 90	00		10	2	03	14	11	1	1	56
				11	1	09	19	12	12	6	27
				12	12	16	42	1	11	11	55
				1	11	27	00	2	10	19	44
				2	10	43	45	3	9	33	22
				3	9	73	16	4	8	63	1

North Reclining 19 28				North Reclining 19 28			
Declining 82 14				Declining 37 54			
Hours		Hour di.		Hours		Hour di.	
12		71	17	2	10	58	44
11	1	40	42	1	11	56	44
10	2	24	38	12	12	48	2
9	3	15	6	11	1	33	2
8	4	8	23	10	2	20	22
7	5	2	53	9	3	8	41
Sub-		stile.		Sub-		stile.	
6	6	2	15	8	4	2	14
5	7	7	40	7	5	13	19
4	8	14	10	6	6	25	17
3	9	23	13	5	7	38	56
2	10	38	8	4	8	55	00
1	11	66	26	3	9	73	45

The other two *South* recline as much, and decline also 60 deg. *viz. b, e f*, and *A, C, E*, have the same *Dials* serving for both, changing the Position of the *Substile*, and *Hours* as afore directed;

The *Requisites* for this *Plane* are as followeth,

The Plane's Declination is — —	48 11
The Declination *East* and *West* —	60 00
The *Dist.* of the *Meridian* and *Horizon*	37 45
The *Substiles* distance from the *Meridian*	16 45
The Plane's Longitude — —	38 31
The Stiles height — —	22 00

This *Dial* is to be made by the Rules of the XVth *Chapter*.

The *Requisites* of two *South* reclining	19 28
viz. g, C, f, and *g, C, E*, do also decline	22 14

and are to be made by the Rules of the XIIIth *Chapter*.

g, f, C, and *g, E, C, South* Reclining —	19 28
Declining *East* and *West* — —	22 14
The distance of the *Meridian* and *Horizon*	82 14
The *Substiles* distance from the *Meridian*	06 26
The Plane's Longitude — —	21 42
The *Stiles* height — —	16 21

The Requisites of the two middle *Planes North* reclining as much, and do also decline 82 14, and are to be made by the Rules of the XVIIIth *Chapter*.

A *North* reclining — —	19 28
Declining East and *West* — —	82 14
The distance of the *Meridian* and Horizon	22 11
The Substiles distance from the Meridian	71

The Plane's Longitude — —	85	25
The Stiles height — — —	19	53

The Requisites of the other two *North* reclinners as much, and do decline 37, 54. and are to be made by the Rule of the XVIth *Chapter*.

A *North* Reclining — —	19	28
Declining *East* and *West* — —	37	54
The distance of the *Meridian* and *Horizon*	75	31
The *Substiles* distance from the *Meridian*	48	02
The Plan's Longitude — —	56	45
The *Stiles* height — — —	56	54

How to CUT

The Body of twelve Rhombs.

THE thirty first definition of *Euclid* defineth a *Rhomb*, to be a Parallelogram, or a Figure consisting of four equal sides, but hath unequal Angles, as out of the Figure *a*, *b*, *c*, *d*, of this Plane may be composed two Bodies, one consisting of twelve *Rhombs*, as the Figure *a*, *b*, *c*, *k*, *h*, *n*, *d*, and the other of thirty *Rhombs*. To cut the Body of twelve *Rhombs*, make 1 Parallelipipped, as is *a*, *b*, *g*, *f*, ; let the length be 10000, as *a*, *b*, or *c*, *g*, the breadth and depth, as *f*, *b*, and *f*, *g*, be 7071, divide the Length into two equal parts, as *d*, *L*, 1. from those Points draw Lines to the Angles, and they shall include four *Rhombs*, as are *m*. 1. *b*. *L*, and *L*, p, *d*, R, &c. Draw upon

upon each end two Diagonal Lines, as *A*, *C*, and *B*, *e*, which joyning at each Angle with the Lines drawn from the middle Point, shall make Triangle such as A. L. C, *&c.* Cut away each Corner by these Triangles, *viz. e*, by the Triangle A, L, C; and so of the rest, so shall you at eight Cuts frame the Body of twelve *Rhombs*, as you see the *Figure* is.

The Body being prepared, set the Angle *c*, of the *Horizontal Rhombs a*, *b*, *c*, *d*, *South*, then will f, h, g, o, be a direct South, and his opposite a direct *North* Dial; the other are all declining a like; whereof the four uppermost do recline 30 deg. and opposites do incline as much; and each doth decline 54 deg. 44 min. *East* and *West*; therefore any two Dials being made, will serve for all the rest, except the North; South, and *Horizontal*.

b. *a*, and *a*, *d*, are *North* reclining 30 deg. and decline 54 44, and are made by the Rules of the XVth *Chapter*.

The distance of the *Meridian* and *Horizon*	54 44
The *Substiles* distance from the *Meridian*	80 47
The Stiles height	44 37
The Plane's Longitude	83 30

The other two Planes as *b*, *c*, *f*, *e*, and *d*, *e*, *g*, *n*, are South reclining 30 deg. and declining *East* and *West* 54 44. and are made by the Rules of the XVIth *Chapter*.

The distance of the *Meridian* from the *Hor.*	54 44
The Substiles distance from the *Meridian*	04 37
The Stiles height	04 [illegible]
The Planes Longitude	45 [illegible]

North Reclining 30				South Reclining 30			
Hours.		Hours distance.		Hours.		Hours distance.	
12		80	48	2	10	32	04
11	1	60	44	1	11	11	05
10	2	43	31	12	12	06	01
9	3	29	12	11	1	03	33
8	4	16	59	10	2	01	55
7	5	06	00	9	3	00	37
Sub-		stile.		Sub-		stile.	
6	6	04	34	8	4	01	13
5	7	15	27	7	5	02	38
4	8	27	28	6	6	04	34
3	9	41	26	5	7	07	52
2	10	58	14	4	8	16	31
1	11	77	59	3	9	87	43

To CUT the

ody composed of 30 Rhombs

THIS *Body* is represented by the Figure L.7 A. E. and is somewhat more troublesome than the former, and is framed out of a C *m g k* dividing every side by extream

mean Proportion, which is thus easily done; Le *a b, b g, b m, &c.* be 10000, then shall *a c, b* *b n, m h, b f, g e, &c.* be 6180, the greater *Seg* *ment*, which taken of a *Sector* opened to the wi dest of any one side, and set from each Angle *a* *g m, &c.* both ways, shall leave *a d, b c, b h, m* *b e, g f, &c.* 3810, the lesser *Segment* of the sam sides, from the Terms of the greater *Segment* o the one side, to the lesser on the other side, draw Parallel Lines, as *d e, a f, b g*, and *q i*, cro them with the like parallel Lines as are *c b, b* *e k*, and *f p*, from each opposite Angle *b k*, an *a g*, unto the lesser *Segment* opposite to the sai *Angles*, draw Parallel Lines, as are *a p, g c, b q* and *k d*; so shall you have the Lines on thi side the Cube necessary for Direction in cutting this Body; and thus must you do with all the rest of the sides: The Line being drawn as you see in the Figure, there is three Triangles framed about every solid *Angle*, as are the Lines *a f h, m d e*, and *g n c*, about the Angle *b*, by which the *Angle* must be three Times cut, continuing each Line as a part is cut away, to avoid Confusion, so shall you at 24 Cuts produce the Body of 30 *Rhombs* desired; which being prepared, set the acute *Angle* N, of the *Horizontal Rhomb* MNRL, *South*, then shall the *Rhomb* OPQK, be a direct *South Dial*, and his opposite a *North*, ABCD, of the Cube (being the same in the Body) *West*, and his opposite an *East* Plane; the rest are all *South* and *North* declining and reclining, as are the three *Rhombs* OPNT, TNRX, *and* TXZO, which are conterminous with the *Horizontal*, and *South*, and *West* Planes, do de-

clin

ne and recline, so do all the rest, as from the
y Inspection of the Figure of the Body doth
ficiently appear: Wherefore having found the
clination and Reclination of these 3 Planes,
re is as much done as is usefull for the Body;
n will you find that OPNT, and KPNC,
ll be two reclining 30 deg. and declining *East*
West 20 deg. 54 min. and T N R X, and
MND, will be *South* Reclining 54 deg. and
clining 56 deg. 16 min. and O T X Z, and
CDE, *South* Reclining 18 deg. and declining
st and *West* 58:16, the three *North* ones will be
: same with the *South* in all Respects, both for
lination and declination; by which means you
y have twenty-four reclining declining *Dials*,
hereof three will be *South* reclining declining
st, and three will have the same declination
st, and will decline the same, and so there will
of the *North* reclining declining *Dials*, and
ch hath his opposite, which recline, and de-
ne as much, and there will be five ordinary
als, *viz.* a *Horizontal*, a *South*, a *North*, an
nd *West*, so will you have twenty-nine
als on this Body. The Manner of making these
als is shewed in the foregoing Chapter. The
quisites and hour *Arches* on their Planes are
followeth.

South Reclining 30 00				South Reclining 54 00.				South Reclinin 18 00.			
Declin. 20 54.				Declin. 56 16.				Declin. 58 1			
Hours.		Hours distance.		Hours.		Hours distance.		Hours.		Hour distan	
5	7	64	2	4	8	81	17	3	9	23	
	6	18	52	5	7	52	14	4	8	8	
7	5	9	43	6	6	33	9	5	7	4	
8	4	5	43	7	5	21	4		6	2	
9	3	3	15	8	4	12	13	7	5	1	
10	2	1	21	9	3	4	58	8	4	0	
Sub-		stile.		Sub-		stile.		Sub-		stil	
11	1	0	21	10	2	1	42	9	3	0	
	12	2	6	11	1	8	34	10	2	1	
1	11	4	10		12	16	30	11	1	3	
2	10	7	6	1	11	26	48		12	5	
3	9	12	26	2	10	47	58	1	11	10	
4	8	27	59	3	9	65	58	2	10	34	

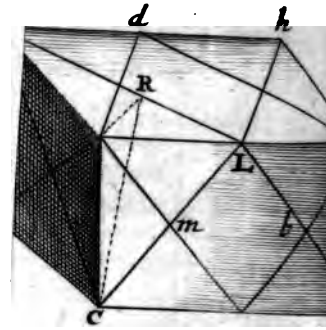
South Reclining [illegible]
Declining *East* and *West* 28
The distance of the *Meridian* and *Horizon* 79
The Substiles distance from the *Meridian* 02
The Stiles height— 06
The Planes Longitude 18

Therefore the Substile stands between 10 11 in the *East-Dial*, and between 1 and 2 in *West-Dial*. And made by the Rules of the 1 *Chapter*.

South Reclining — — — — —

22
29
10
51
and
We
KV

O
I
2
2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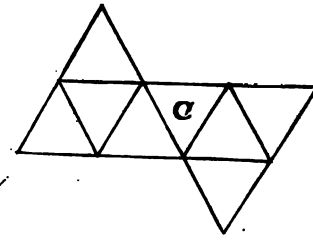
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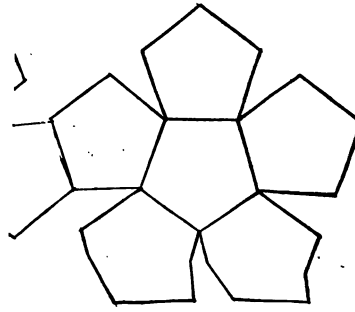

clining *East* and *West*	56	16
e distance of the Meridian and Horizon	37	22
e Subſtiles diſtance from the *Meridian*	16	29
e Stiles height	26	10
e Planes Longitude	33	51

which means the Subſtile falls between 9, and in the *East*, and between 2 and 3 in the *West* cliner. And made by the Rules of the XV. apter.

th Reclining	18	00
clining *East* and *West*	58	16
e diſtance of the *Meridian* and *Horizon*	63	26
e Subſtiles diſtance from the *Meridian*	05	28
e Stiles height	03	57
e Planes Longitude	54	11

By which means the Subſtile will fall between and 9, in the *East*, and between 3 and 4, in *West* Decliner. And made by the Rules of 12*th* Chapter.

Cutting of the five Regular Bodies in Paſt Board.

1. THE Cube is compoſed of ſix Geometrical Squares, as *A*.

2. The *Tetrahedrum* is compoſed of three Equatral Triangles, as *B*.

3. The *Octohedrum* is compoſed of ſix Equilatral Triangles, as *C*.

4. The *Dodecahedrum* is compoſed of twelve Equilatrial Pendegons, whoſe ſides are equal, and Angles 72 deg. as *D*.

5. *The Icoſhedrum* is compoſed of twenty Equatrial Triangles, as E.

hese Bodies being ſo cut will fold up, r as the ſolid Bodies.

North Reclining 30.00 Declin. 20. 54				North Reclining 54. 00 Declin. 58. 16.				North Reclin. ing 18. 00 Declin. 58. 16			
Hours		Hours distan.		Hours		Hours		Hours		Hours distan.	
4	8	74	40	2	10	87	5	1	11	87	54
5	7	58	27	3	9	69	13	2	10	62	20
	6	43	2	4	8	52	27	3	9	42	26
7	5	28	29	5	7	37	12	4	8	27	58
8	4	14	35		6	23	20	5	7	16	56
9	3	1	5	7	5	10	27	6	6	7	45
Sub-		stile.		Sub-		stile.		Sub-		stile.	
10	2	12	23	8	4	1	59	7	5	0	39
11	1	26	11	9	3	14	31	8	4	9	6
	12	40	37	10	2	26	46	9	4	18	30
1	11	55	53	11	1	41	56	10	2	29	56
2	10	72	00		12	57	40	11	1	45	8
3	09	88	38	1	11	74	52		12	66	59

North Reclining 30 0[illegible]
Declining *East* and *West*, 20 5[illegible]
The distance of the *Meridian* and *Horizon* 79 1[illegible]
The Substiles distance from the *Meridian* 40 3[illegible]
The Stiles Height 63 2[illegible]
The Planes Longitude 43 4[illegible]

This *Dial* is made by the Rules of the 16[illegible] *Chapter.*

The North Reclining 54 [illegible]
Declining *East* and *West* [illegible]
The distance of the *Meridian* and Horizon

ıe *Subſtiles* diſtance from the *Meridian* 57 40
ıe *Stiles* height 55 39
ıe *Planes* Longitude 62 24
This *Dial* is made by the Rules of the XVIII. *apter.*
ıe *North* Reclining 18 00
eclining *Eaſt Weſt* 58 16
he diſtance of the *Meridian* and *Horizon* 63 26
he *Subſtiles* diſtance from the *Meridian* 65 59
he *Stiles* Height 33 34
he *Planes* Longitude 76 11
This *Dial* is made by the Rules of the XVI *hapter.*

And thus you have all the *Tables* and *Requi-es* belonging to all the Bodies mentioned in is Book. *Note*, That upon all *South* reclining clining Dials, the declination of the *Meridian* Planes Longitude, is accounted from the Noon *Meridian*; And upon all *North* declining reclining ials, leſs than a Polar Dial, the Planes Longi-de is reckoned from the Midnight *Meridian*, twelve a Clock at Night, and in all Polar Di-s it may be accounted from either Noon, or idnight, becauſe the Longitude of the Plane is ways 90 deg. and in all *North* declining recli-ng Dials, more than a Polar, it is fonnd from the idnight Meridian, but the Complement to 180 eg. is the difference of Longitude, from the *uth*, ſee Page 122.

You have in Figure 36, a Dial which ſheweth y the ſhade of the Stile, what People, whether *Sea or Land*, have the Sun juſt over their Head *ſuch a time* as you look upon the Dial; whi

is performed by inverting that part of the *Terrestrial Globe*, which is included between the two *Tropicks*.

The Reason of this Inversion is, that the shadow the Stile being always cast towards to contrary part to the Sun, that is, if the Sun be *East*, his shade falls towards the West, *&c.* therefore is it necessary that the *Eastern* part of the World should lie Westward, and the *Northern* part *Southward*.

These Dials are best to be *Equinoctial* ones, on which this sort of Furniture is discribed, for it appears the best on these sort of Planes: The making of an *Equinoctial* is taught in Page 20, and this Furniture described after this manner; Your Dial being made, and a *Trigon*, as in Page 135, put into your *Trigon*, (besides the *Tropicks* and *Equinoctial*) 5, 10, 15, and 20 deg. of Declination, for that answereth on this Dial, for 5, 10, 15, and 20 deg. of Latitude from the *Equinoctial*, and transfer them (in obscure Lines) from your *Trigon* to your *Plane*; this being done, your *Perpendicular Stile* being made *Radius*, set the *Tangent* of 5, 10, 15, and 20, from the twelve a Clock Hour-Line, and draw obscure Lines thro' the Points parallel to the twelve a Clock, and they shall represent your Longitude, your Dial is ready for to describe your Furniture; then take a Map of the Place you desire to draw on your Dial, and turn the bottom upward, and describe the Country, according to its Latitude and Longitude, and your Work is done.

FINIS.